Implementing Cycle Time Reduction In Product Development

by

Steven C. Goldt

B.S., Mechanical Engineering, University of California, San Diego (1988)

Submitted to the MIT Sloan School of Management and
to the Department of Mechanical Engineering
in Partial Fulfillment of the Requirements for the Degrees of

Master of Science in Management
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Signature of Author _____
MIT Sloan School of Management
Department of Mechanical Engineering
May 1, 1995

Certified by _____
Steven D. Eppinger
Associate Professor of Management Science
Thesis Advisor

Certified by _____
Daniel E. Whitney
Senior Lecturer of Mechanical Engineering
Thesis Advisor

Accepted by ____
Jeffrey A. Barks
Associate Dean, Sloan Master's and Bachelor's Programs

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Abstract

This thesis examines the challenges of implementing cycle time reduction in product development. It characterizes the process of cycle time reduction at a program level and at a project level. The initiation and ongoing development of a major cycle time reduction program will be analyzed with respect to the organizational culture in which it is being implemented. Within the context of that program, a methodology for conducting process improvement projects will also be evaluated.

A cycle time reduction program must adapt to its target organization. The biggest problems are not technical or analytical, they are organizational. This thesis will focus on critical success factors from an organizational perspective. A cultural analysis of the organization will be presented. The phased approach of the cycle time reduction program will be described in detail. Then, cultural related challenges will be linked to program specific recommendations.

A cycle time reduction program must also facilitate process improvement projects. One such project became a significant element of this research. The goal of the project was to improve material management in the early phase of product development. The direct experience provided by this project highlighted a number of implementation tools and techniques. The methodology used in this project will be described and critiqued. This evaluation will be followed by a set of generalizable lessons learned during the course of the improvement project.

Acknowledegments

This thesis would not have been possible without the support and encouragement of many individuals. To all that have contributed, I am sincerely grateful.

I am grateful to everyone in my host company for providing an invaluable learning experience.

I would also like to thank my thesis advisors for their expertise, guidance, and support. Steven Eppinger and Daniel Whitney provided in depth knowledge of product development. Their insightful questions and unique perspectives led me to explore learning opportunities that I would have otherwise missed.

I also wish to thank the MIT's Leaders for Manufacturing Program for its support of this work.

Finally, I want to thank my wife Cristina, for the many sacrifices she made throughout my internship, and the entire LFM program.

Editing Note

To protect proprietary information, this thesis was significantly edited by the host company sponsoring this research.

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1 Introduction

The research for this thesis was conducted during a six month on-site internship as part of MIT's Leaders for Manufacturing (LFM) Program. The LFM program is a partnership between MIT and 13 major U.S. manufacturers. The internship forms the cornerstone of a 24 month program focusing on all aspects of a manufacturing enterprise - product development, sales and marketing, production, as well as financial and information support services. During the internship, the disciplines of engineering and management are applied to a problem defined by the host company.

1.1 Motivation

Time based competition is not a new concept. The benefits of reducing total cycle time are well documented by authors such as Stalk and Hout[1], Thomas[2], Smith and Reinertsen[3], and Blackburn[4]. For many companies today, the logic is clear and the need is well recognized. However, one time reductions are not enough. Organizations are working to institutionalize an ongoing commitment to total cycle time reduction.

The benefits of total cycle time reduction go beyond higher profits and increased market share. Total cycle time reduction can be viewed as a tangible objective that leads to a higher goal of organizational learning. The ultimate core competency is being able to create and maintain a rate of improvement greater than that of all competitors. To the extent that we learn from experience, that rate of improvement depends upon the rate at which process cycles are completed. Fast cycle times lead to rapid iterations which in turn increase an organization's ability to learn and improve.

Companies pursuing cycle time reduction are searching for ways to achieve these benefits.
Recent business literature and professional management consultants are quick to provide high level strategies. However, effective strategies are not enough. Cycle time reduction requires organizational change. Benefits cannot be achieved without implementing change.

Companies facing this challenge must decide where to focus their efforts. Upstream organizational processes are being targeted because they offer the highest leverage points for improvement. Increasingly, these efforts are being directed toward the process of product development. It is the source of many cycle time issues in downstream processes

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[1]George Stalk and Thomas Hout. Competing Against Time. The Free Press. New York, NY. 1990.
[2]Philip R. Thomas. Competitiveness Through Total Cycle Time. McGraw Hill. New York, NY. 1990.
[3]Preston G. Smith and Donald G. Reinertsen. Developing Products in Half the Time. Van Nostrand Reinhold. New York. 1991.
[4]Joseph D. Blackburn. Time-Based Competition. Business One Irwin. Homewood, IL. 1991.

organization. The challenge of implementing cycle time reduction in product development provided the motivation for this thesis.

1.2 Problem Definition

The problem defined by the host company can be defined at two levels. At a strategic level, the challenge is to reduce cycle time in product development, decrease time to market, and increasingly capitalize of the market window for products. At a tactical level, the challenge is to implement and institutionalize improvements that reduce the time required to complete sub-processes within product development.

This project highlighted a number of general issues that apply to multi-functional process improvement efforts. How can an effective team be built? How does the team go from a list of improvements to specific implementation responsibilities? How are the successes of one team rolled out across an organization?

1.3 Thesis Objectives

Given the problem defined above, there are two major objectives for this thesis. The first is to characterize the process of cycle time reduction in product development. The second is to identify and evaluate tools and techniques that facilitate the process.

Cycle time reduction will be characterized at a program level and at a project level. At a program level, the initiation and ongoing development of a specific cycle time reduction program will be analyzed. Key elements will include organizational culture, communication, and executive participation. At a project level, the methodology of a multi-functional problem solving team will be evaluated. The direct application of that methodology highlighted a number of important lessons.

1.4 Key Findings

The lessons from this research can be summarized into the following program level and project level findings:

1.4.1 Program Level

A cycle time reduction program should be customized to fit the organizational culture in which it is being implemented. There will be unique challenges in every product development community. For example, multi-functional teaming and common processes may not be central elements of an organization's culture. A cycle time reduction program

must recognize these types of challenges and develop an approach that utilizes the strengths of the organizational culture.

In a lean operating environment, infrastructural mechanisms are an important means of shifting attention from product to process. Process related metrics and recognition forums can elevate the importance of viewing product development as a process. These types of mechanism can help create a balance between product innovation and process innovation.

Program level support from senior level management should include tangible contributions. Verbal encouragement is necessary but not sufficient. Senior level management can actively participate in a cycle time reduction program by:

- Striving to reduce or eliminate cycle time for management approvals
- Making personal appearances at recognition forums a high priority
- Developing and implementing a modified performance system
- Writing newsletter articles, holding brown bag lunches, and delivering speeches
- Sitting in on steering committee meetings

1.4.2 Project Level

Looking for problems will create defensiveness. When investigating improvement opportunities, a project facilitator must recognize that individuals may react defensively. When interviewing individuals, it is important to put their feedback into perspective. Rather than taking interview feedback as factual data, it is important to understand the framework of the interviewee and the potential sensitivities of that person.

Team building requires personalized selling. Unless an individual can envision direct personal benefits from volunteering for a process improvement project, that person is unlikely to participate. A project facilitator must relate potential improvements to an individual's specific work problems and their impact on the quality of work life.

Developing common understanding should be the first step in process analysis and redesign. At the beginning of a project, multi-functional team members will have different understandings of the process. "As Is" process mapping is a valuable tool for overcoming these gaps. Without a common understanding, process improvement efforts will be hampered by difficulty in reaching consensus among the team.

The necessary information is usually available. Process improvements often require data to be provided in a new format at a specific time. In this case, the problem is not a lack of data. The data is just not available to those that need it. By asking "what if", it may be easy to eliminate information silos that prevent rapid decision making. This finding has three related corollaries:

MIS must become better marketers. MIS can play a valuable role in cycle time reduction by taking an active role in process improvement projects, explaining what is feasible, and adopting a proactive approach to information system needs.

Functional groups must become better customers. In this context, the word "better" implies more demanding from the perspective of improving business processes. The question "what if" needs to be asked much more frequently.

A common language is needed. Functional and IS individuals need to recognize that they each speak different "languages." Together, they can develop a common language, unique to their own interactions, that is characterized by frequent verification of assumptions and by consideration for each other's perspective.

There is no substitute for persistence and energy. A project facilitator is a change agent that will encounter many unexpected barriers - both technical and organizational. Persistence and constancy of purpose are major factors in persuading change-resistant individuals. Even the smallest lapse into negativism or the slightest instance of skepticism will be recognizable and eliminate opportunities to gain support or resources.

1.5 Research Methodology

In a spirit of partnership, the methodology for this research was influenced by the company supervisor, the author, and two MIT faculty advisors. Given that the research was conducted as part of an internship, the company supervisor emphasized the need to generate a specific deliverable. On the other hand, the two faculty advisors emphasized the need to develop a general understanding of product development as a multi-functional process.

To satisfy both of these needs, the research combined elements of both observation and participation. As a member of the staff group chartered with cycle time reduction, the author was given the opportunity to develop a general understanding of the multi-functional product development process. This understanding came as a byproduct of observing and contributing to the initial stages of a cycle time reduction program. This element of the research provided a culturally rich case study highlighting:

- program related implementation tools and tactics
- difficulties generating and measuring tangible cycle time improvements
- the role of factory builds in product development

As a facilitator for a specific cycle time reduction project, the author was also given the opportunity to generate specific deliverables. In particular, the goal was to develop tangible cycle time improvements in the early phase of product development. This element of the research provided an in-depth case study highlighting:

As a facilitator for a specific cycle time reduction project, the author was also given the opportunity to generate specific deliverables. In particular, the goal was to develop tangible cycle time improvements in the early phase of product development. This element of the research provided an in-depth case study highlighting:

- project related implementation tools and tactics
- challenges associated with multi-functional problem solving teams
- challenges associated with the diffusion of innovation
- the role of material management in factory build cycle time

1.5.1 A Specific Program

A major component of this research utilized the author's role as an outside observer. Entering as an outsider, the author was in a unique position to observe organizational dynamics associated with the cycle time reduction program. The methodology in this research component emphasized the value of observation, inquiry, and validation using an approach similar to what Schein[5] describes as the iterative clinical interview.

This research component did not produce tangible cycle time savings that could be measured or verified. Instead, the goal in this case was to develop a model of the organizational culture and use this model to develop a set recommendations for the cycle time reduction program as it matures from initiative to institutionalization. The context of this research component is shown in Figure 1.5.1.

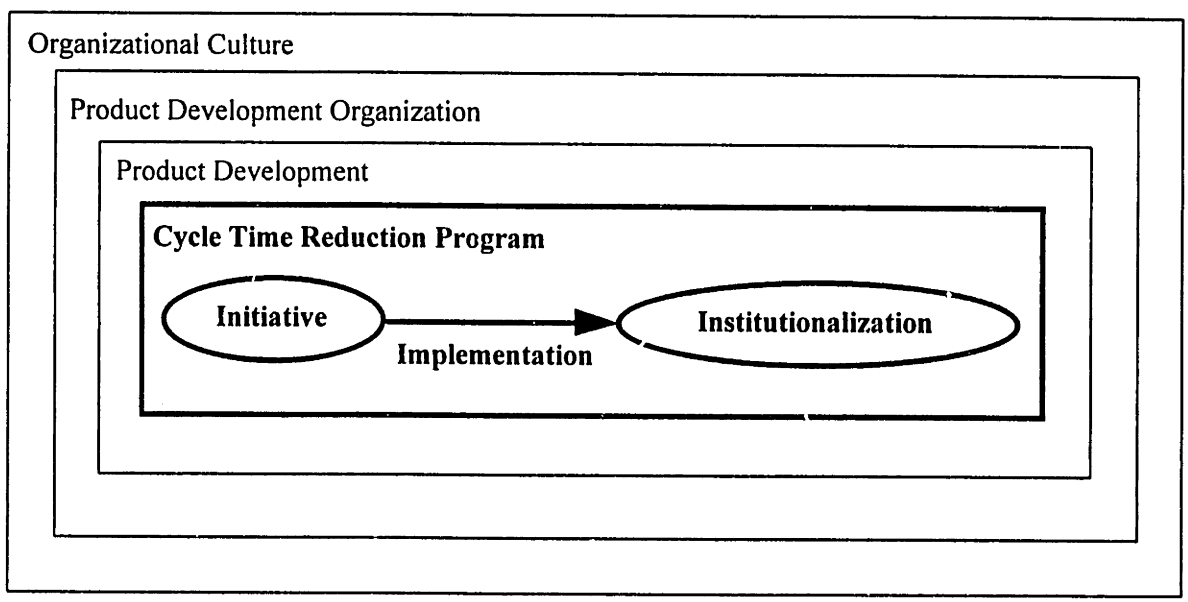


Figure 1.5.1 Context of the cycle time reduction program

[5]Edgar H. Schein. Organizational Culture and Leadership. Jossey-Bass Publishers. San Francisco, CA. 1992. pp. 169-177.

The activities associated with this research component are listed below:

- Enter and Focus on Surprises
- Share Observations with an Insider
- Jointly Develop Explanations
- Formalize Hypotheses about Basic Assumptions
- Validate Hypotheses with an Insider
- Develop a Model of the Organizational Culture
- Develop Recommendations for the Program Based on the Model

1.5.2 A Specific Project

It has been said that the best way to understand something is to try to change it. With this principle in mind, this research also included a specific cycle time reduction project. In this research element, the methodology emphasized the value of direct experience. By focusing on tangible deliverables, the project exposed specific implementation challenges. Through direct intervention, the author was able to evaluate a variety of implementation tools and tactics.

In this research component, the author coordinated a multi-functional cycle time reduction project focused on material management. The context of this project is illustrated in Figure 1.5.2.

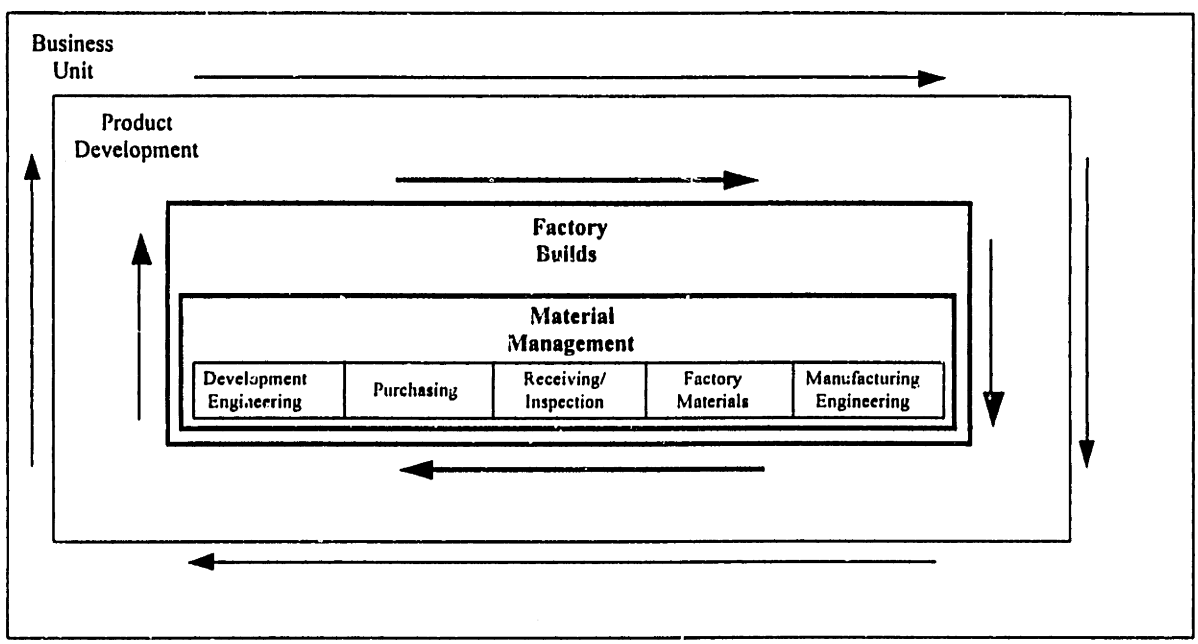


Figure 1.5.2 Context of the cycle time reduction project

The activities associated with this project are summarized below:

- Horizontal Deployment
- Project Postmortem

1.6 Thesis Layout

This thesis is organized as follows:

Chapter 2: What is Cycle Time Reduction? Prior to the specific cases presented in Chapters 3 and 4, Chapter 2 provides a general definition of cycle time reduction. This chapter establishes a foundation that integrates the remainder of this thesis.

Chapter 3: This chapter uses a specific case to characterize cycle time reduction at a program level. The case focuses on efforts to institutionalize a program of cycle time reduction in the business' product development organization.

Chapter 4: This chapter uses a specific case to characterize cycle time reduction at a project level. The case focuses on efforts to improve a high leverage sub-process within product development.

Chapter 5: This final chapter presents the conclusions and provides recommendations for future research.

2 Fundamentals of Cycle Time Reduction

As previously noted, a major objective of this thesis is to characterize the process of cycle time reduction. What is cycle time reduction? There are a wide variety of definitions that entail large differences in scope. In carrying out this research, the author developed a unique interpretation of cycle time reduction. That interpretation is the result of direct experience and a synthesis of ideas from several authors. This chapter will describe that interpretation.

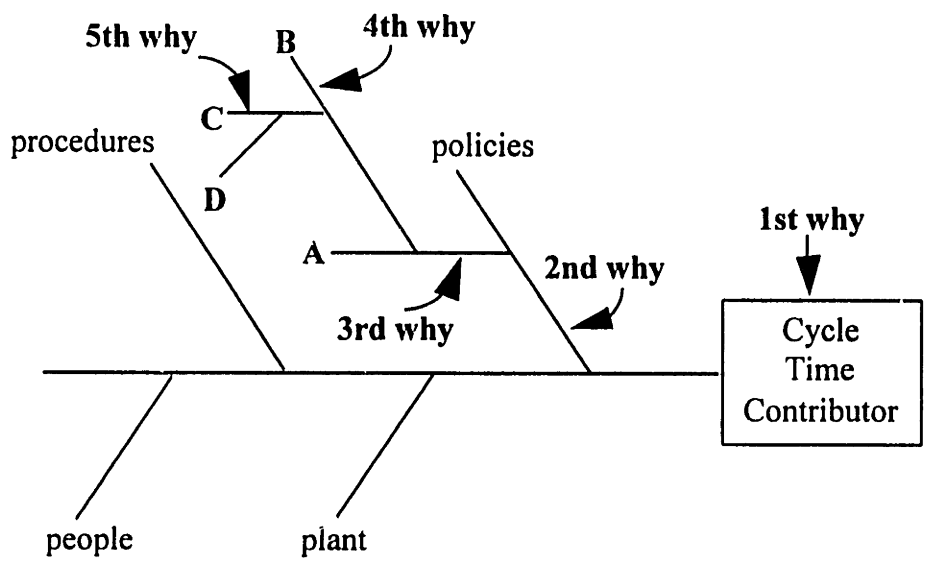
2.1 Cycle Time Reduction: A Management Philosophy

This section will describe a number of elements that are central components of cycle time reduction as a management philosophy:

Systems Thinking/Process Focus:

Effective cycle time reduction requires systems thinking and a focus on the process that generates a problem or contributes to cycle time. A process focus allows individuals to discuss problems without needing to place blame on a particular individual. Problem solving sessions are not emotionally charged at a personal level. This emotional detachment allows team members to focus on the root cause of problems. When individuals are not forced to defend themselves, it becomes easier to complete a thorough analysis of the "5 Whys" as described by Shiba[6] (see Figure 2.1.1 and Table 2.1).

Figure 2.1.1 Cause and Effect Diagram



[6]Shoji Shiba, Alan Graham, and David Walden. A New American TQM. Productivity Press. Cambridge, MA. 1993. pp. 119-121.

Table 2.1 "5 Whys" in Root Cause Analysis

Why?	Answer:
Why is there a cycle time contributor?	Policies
Why are the policies a problem?	A
Why is A a problem?	B
Why is B a problem?	C
Why is C a problem?	D

Tasks evaluated on the basis of value added to the external customer:

The complexity of business processes usually increases with the size of an organization. It is common to hear the term "internal customer" in reference to the output of individual tasks that are pieces of larger processes. When this happens, improvement efforts tend to focus on optimizing pieces of a process rather than the whole. When focusing on satisfying internal customers, the effect of internal politics can result in suboptimization that actually reduces value to the external customer. For example, if the manager of incoming inspection is treated as a "customer," improvement efforts may focus on how to facilitate inspection. In some cases, it may be better to improve the process in such a way that inspection is no longer required.

Open and direct information flow:

In product development literature, functional "silos" or "chimneys" are almost always cited as a barrier to rapid product development. Using this same terminology, there is another cycle time contributor that is equally destructive: information silos. This term refers to the pockets of information generated and maintained by particular organizational groups. When this information is unavailable to other groups in the organization, the result can be lengthy decision making cycles. Closed communication channels prevent timely decision making. Organizations should work to overcome technical and security considerations while striving to integrate information systems.

Few disconnects between functional boundaries:

Opportunities for cycle time reduction often occur in the white space between functional boundaries. In many cases, multi-functional business processes lack a single process owner. For example, there may not be one person responsible for all the tasks required to procure and stage material. Without a single focal point, it is rare to find a common understanding across various functional groups. Without a common understanding of the process, it is difficult to identify non-value added tasks or disconnects. A significant

aspect of cycle time reduction is an ongoing effort reduce white space between functional boundaries.

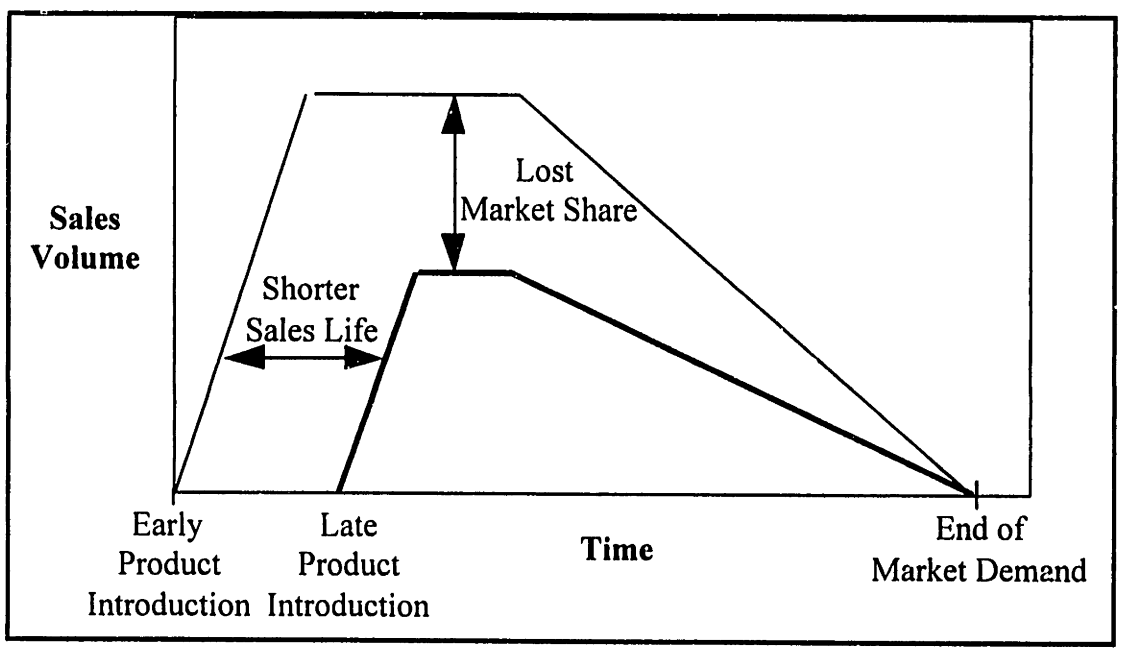
Resources allocated to non-manufacturing process development:

In product development, product elegance usually takes precedence over process performance. Dedicated resources such as manufacturing engineers are continually working to improve manufacturing processes. In product development however, a parallel job function rarely exists. Knowledge work in development engineering is less tangible and much less repetitive than a manufacturing process. However, the need for continuous improvement is just as great. "One cannot simply will non-value-added work away."[7] Cycle time reduction requires up front commitment during project scheduling. Individuals participating directly in the product development cycle should have a set percentage of their time dedicated to improving the process.

Cost of time to market delays are factored into trade-off analyses:

In order to make educated decisions regarding resource allocations, it is helpful to have some form of model that factors in all of the costs and benefits of a particular decision. In many cases, the true cost of time to market delays are not factored into the decision making process. The market window for a particular product or technology usually has a fixed end point (see figure 2.1.2). Within that window, profit margins generally decline as that end point approaches. A loss of revenue and possibly market share should be included in the model that is used for trade-off analyses.

Figure 2.1.2 Implications of a Fixed Market Window



[7]Christopher Meyer. Fast Cycle Time. The Free Press. New York, NY. 1993. pp. 180.

Bottleneck management is applied to product development:

In the proper spot, excess capacity can reduce bottlenecks in a manufacturing operation. The same can be said for product development in terms of human capacity or the availability of engineering tools. For example, it may not make sense for a scarce resource such as a talented engineer to spend a large percent of her time on administrative duties. In the drive to create lean organizations, bottleneck management becomes an important consideration. Cycle time reduction requires the ongoing identification and management of bottlenecks as part of a product development organization's focus on process and time to market.

What cycle time reduction is not:

In concluding this section, it important to identify several misconceptions about cycle time reduction. To drive out fear and to increase the chances for improvement, management must address some common assumptions. Cycle time reduction is not about working harder, faster or longer hours. Also, technology, automation, and job losses are not the goal of cycle time reduction. And finally, cycle time reduction is not a one shot goal with a fixed end point. It needs to be institutionalized as an ongoing commitment to continuous improvement and learning.

2.2 Cycle Time Reduction: An Umbrella and a Beacon

This section will use two additional perspectives to help define the concept of cycle time reduction. The images of an umbrella and a beacon will be used to symbolize the benefits of using cycle time reduction to drive continuous process improvement.

In his book describing secrets of Japanese success, Imai[8] describes three critical components of continuous improvement: cost, quality, and delivery (ie. cycle time). In that text and in many texts describing total quality management, each of these three components are equally deserving of management attention. However, each of the three components are not equally effective as a impetus for generating organizational change. Without sacrificing cost or quality, cycle time reduction can provide a focused goal that transcends organizational boundaries and clearly applies to both manufacturing and non-manufacturing processes.

Cycle time reduction can be viewed as an umbrella because it incorporates both cost savings and quality improvement. If a process includes many inspection points and lengthy rework tasks, will there be short cycle times? Similarly, what would happen to

[8]Masaaki Imai. Kaizen: The Key to Japan's Competitive Success. McGraw-Hill Publishing, New York, NY. 1986.

costs if the time consumed by a development process were cut in half while using the same size team? Poor quality and high costs do not lead to short cycle times. Improvements in quality and cost naturally fall under the umbrella of cycle time reduction (see Figure 2.2.1).

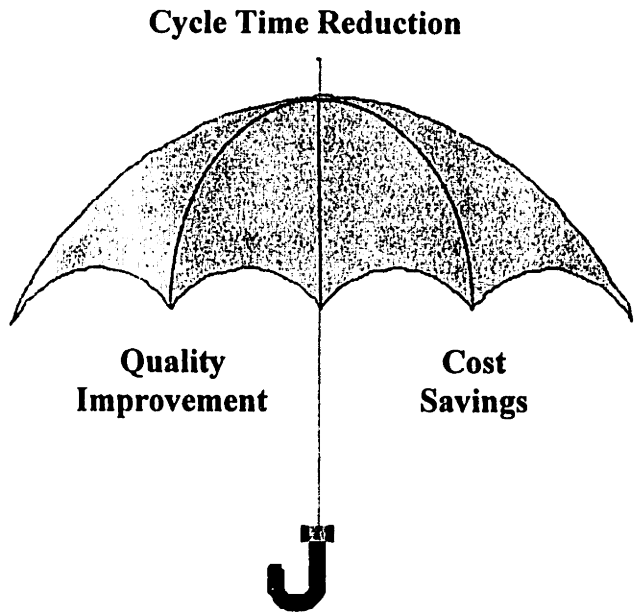


Figure 2.2.1 Cycle Time Reduction as a Strategic Umbrella

Cycle time reduction can also be viewed as a beacon that communicates across wide areas and highlights opportunities for improvement. In upstream processes such as product development, the definition of quality is not always clear, particularly compared to quality on the shop floor. On the other hand, time is difficult to misinterpret. Because time has the same meaning in all business processes, it can be used to communicate across functions as a target for improvement efforts. In addition, long cycle times are often a first indication of poor quality, regardless of the exact definition for a defect. In this way, cycle times can shine a light on quality problems or opportunities for cost savings.

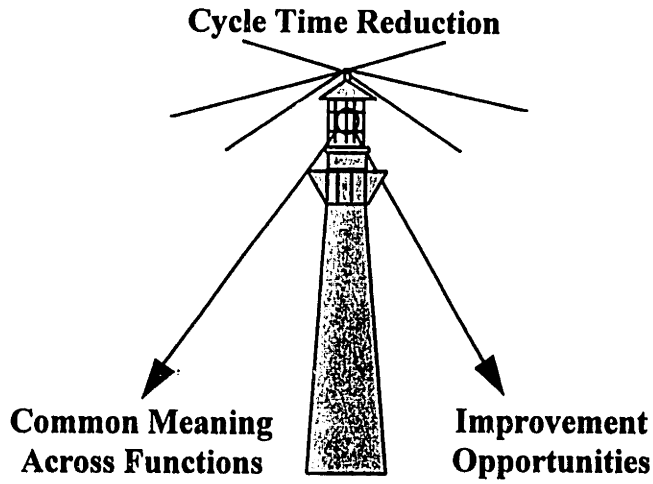


Figure 2.2.2 Cycle Time Reduction as an Organizational Beacon

2.3 The Link Between Cycle Time Reduction and Organizational Learning

In the last several years, much has been written on the topic of organizational learning. It has been dubbed by some as the only sustainable source of competitive advantage. One of the first to draw a connection between organizational learning and fast cycle times was Christopher Meyer[9]. He argues that organizational learning is a foundation for "Fast Cycle Time." He also suggests a number of techniques that can increase an organization's ability to learn from past experience. His arguments are convincing in that cycle time reductions would not be possible without organizational learning.

However, it is also true that cycle time reductions can facilitate organizational learning. If an organization learns from experience, it makes sense that shorter cycles lead to an increasing number of learning opportunities. In the electronics industry, Sony provides a good example of rapid cycles of learning. Their business strategy incorporates rapid product introductions followed by rapid enhancements and fine tuning based on market feedback. A key element of this strategy is that the external marketplace becomes a source of learning.

To summarize, continuous process improvement is an intermediate goal of cycle time reduction. A longer term goal is the development of a core competency based on rapid rates of organizational learning.

[9]Christopher Meyer. Fast Cycle Time. The Free Press. New York, NY. 1993. pp. 72-84.

3 Implementing Cycle Time Reduction - A Specific Program

3.1 Introduction

This chapter will attempt to characterize the process of cycle time reduction by describing and analyzing an actual cycle time reduction program. The goal is to translate the author's direct experience into a case study that disseminates generalizable lessons. Ideally, the following case study provides a story that can be classified as a learning history:[10]

> "A learning history is a tool for learning. Learning histories can help their readers to become more capable and effective in designing their own actions. We propose the use of analysis and storytelling to communicate significant learning. ...
>
> A learning history should also provide sufficient details to illustrate the insights of the participants and provide a basis for comparison with their (the readers') own experiences."

The cycle time reduction program in this case is focused specifically on product development. The case describes the life of the program over the first year of its existence.

3.2 Background

3.2.1 A New Charter

A new team was created to begin addressing the bold objective of significantly reducing product development cycle time. Previously engaged in the field of manufacturing systems, the group soon found itself in an entirely new organizational setting that included the development engineering and materials communities.

After several weeks of formulating and refining broad goals, an initial charter was formalized. The new cycle time program would:

- Enhance the decisions made during the development process by enabling the flow of design, manufacturing, and materials information throughout the design process.
- Decrease the overall cycle time and resources spent in manufacturing and materials.

[10]George Roth & Art Kleiner. Notes from Learning History Conversation at Bretton Woods Conference June 27th 1994.

- Define, measure, and improve the development process by identifying, acquiring, and implementing state of the art analysis and simulation tools.

This new initiative became known as the Cycle Time Reduction (CTR) Program. These objectives applied across all groups within the organization.

3.2.2 History of the CTR Team

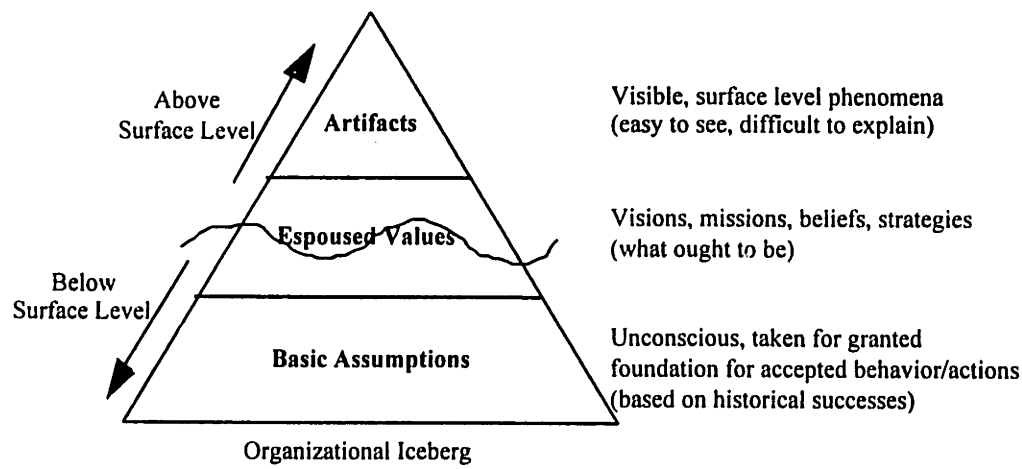
The responsibility for initiating this new CTR Program was given to a group known as Cycle Time Reduction Team (CTR Team). The program's evolution will be described from the author's perspective as a member of the CTR Team.

3.2.3 Organizational Culture

To lay the groundwork for the remainder of this learning history, one final piece of background is necessary. To better comprehend the evolution of the CTR Program, it is helpful to understand various aspects of organizational culture within the local facility. This section will draw upon concepts and frameworks developed by Edgar Schein[11] to describe the culture of the organization in which this research took place. The analysis will be limited to specific cultural elements that relate to the goal of institutionalizing an ongoing program of cycle time reduction.

Since culture is both complex and intangible, descriptions of organizational culture benefit from the use of a structured framework. Using Schein's framework, this analysis distinguishes three separate levels of culture: *artifacts, espoused values, and basic assumptions* (see figure 3.2.3.1).

Figure 3.2.3.1 Three distinct levels of culture



Artifacts are those unique structures, processes, and items in a work environment that are relatively easy for an outsider to observe. Usually promoted by management, espoused values are business philosophies that underlie many surface level artifacts. In cases where an artifact cannot be explained by an espoused value, a resolution to the conflict can be found at the deepest level of basic assumptions.

[11]Edgar H. Schein. Organizational Culture and Leadership. Jossey-Bass Publishers. San Francisco, CA. 1992.

Table 3.2.3.1 provides a list of the artifacts, espoused values, and basic assumptions that affect the local facility's ability to achieve a reduction in product development cycle time. The matrix format adds context to the individual cultural elements. The context is provided by linking each cultural element (vertical axis) to one or more cultural dimensions (horizontal axis) as defined by Schein. These cultural dimensions help to clarify the significance of the artifacts, espoused values, and basic assumptions. If an individual cell within the matrix is filled with an X, then there is a relation between that cultural element and that cultural dimension. For example, look at the artifact which is named "Individuals leave meetings to answer pages." That artifact has significance relative to the cultural dimensions of "Relationship Norms" and the "Nature of Time."

Table 3.2.3.1
Matrix of Cultural Elements
at the U.S. Facility

	External Environments					Internal Integration						Abstract Assumptions					
	Mission & Strategy	Goals	Means	Measurement	Correction	Common Language/Concepts	Group Boundaries	Distributing Power/Status	Relationship Norms	Rewards & Punishment	Explaining the Unexplainable	Reality & Truth	Nature of Time	Nature of Space	Nature of Human Nature	Natue of Human Activity	Human Relationships
Artifacts																	
Small successes								X		X			X		X		
Length of service parties								X		X		X					
It is common to arrive at meetings late									X				X				
It's ok to miss meetings w/out notification									X				X			X	X
Individuals leave meetings to answer pages									X				X				
"I'm always fighting fires"													X			X	
Specialized engineers doing administrative work	X						X								X		
No name for factory materials workers							X										
Manufacturing engineers doubling up in desks														X			
Promotions from within are the rule			X					X					X			X	
Conservative compensation packages			X												X		
Very little on-site inventory space	X													X			
Distribution is a "different" organization							X		X								
Lack of consensus prevents closure								X	X								X
Many non-common information based tools								X								X	
Equipment & processes differ across factories								X							X		
Espoused Values																	
Customer satisfaction	X	X															
Quality		X															
Integrity			X														
Values constant improvement	X																
Employee dignity			X														
Respect senior service			X														
Protect the environment		X															
Basic Assumptions																	
Individual experience is valuable								X					X			X	
The present matters most													X				
Just try it																X	
Individuals have a right to veto group decisions									X			X					
The business has some of the best talent in the world			X									X					

A variety of mechanisms were used to generate the contents of Table 3.2.3.1. Surprising observations were the primary source for identifying surface layers (artifacts) of the organization's culture. Well documented corporate initiatives were used to collect a list of espoused values. And finally, insider feedback and confirmation were used to compile the list of basic assumptions.

As Schein suggests, each of the levels of culture are related to one another. The individual cultural elements in Table 3.2.3.1 are related to one another in a complex manner that is difficult for an outsider to understand. However, it is possible to characterize key pieces of that complex interrelationship. Focusing on the deepest level of culture, the organization's basic assumptions will be isolated and explained. In the following analysis, one or more artifacts will be used to illustrate the manifestation of each basic assumption:

Basic Assumption: Individual Experience is Valuable

Related Artifacts:

- Length of service parties
- Many non-common information based tools
- Equipment & processes differ across factories

This group of artifacts all point to a basic assumption that experience is highly valued in the organization. Individuals have to earn respect across the organization through quick wins and length of service. However, once an individual has developed a track record and earned that respect, it is expected that he will solve problems on his own using unique solutions that are best suited to his environment. In this sense, there is a much higher value placed on an individual's experience than group experience. Most learning occurs at an individual level.

Basic Assumption: The present matters most

Related Artifacts:

- Individuals leave meetings to answer pages
- "I'm always fighting fires"

This group of artifacts points to the culture's abstract assumption about the nature of time. In many cases, the most respected individuals are those that are the problem solving "fire fighters." Little effort goes into future considerations such as the organization-wide deployment of factory/project specific improvements. The present-focused orientation also hinders efforts to learn from the past. For example, postmortems for development projects are rarely conducted.

Basic Assumption: Just try it

Related Artifacts:

- Many non-common information based tools
- Equipment & processes differ across factories

These two artifacts are surface level indications that experimentation is accepted at all levels of the organization. There is an attitude of put up or shut-up. Instead of planning and analyzing something to death, there is a preference for rapid action. There is a general willingness to change, especially when it improves productivity. This just try it mentality applies at all levels in the organization.

Basic Assumption: Individuals have a right to veto group decisions

Related Artifacts:

- Lack of consensus prevents closure
- Many non-common information based tools
- Equipment & processes differ across factories

These artifacts are additional indications of the value that the organization places on individuals. This author experienced one meeting in which 12 team members spent 45 minutes trying to convince one individual to go along with an implementation recommendation. Because that individual refused to "give in," the entire team agreed to forego the recommendation. This basic assumption about the rights of individuals has a significant impact on efforts to develop common processes and tools across multiple groups within or across organizational functions.

Basic Assumption: The business has some of the best talent in the world

Related Artifacts:

- Length of service parties
- Promotions from within are the rule
- Conservative compensation packages

In this case, cause and effect are somewhat muddled. However, the business feels that it possesses some of the best engineering and management talent available. Management is generally promoted from within the organization. Relatively conservative compensation packages are offset by the opportunity to learn from and be a part of a world class organization. A moderate "not invented here" syndrome is one of the byproducts of this assumption regarding the level of talent within the business. Clearly, this has an impact on the ability of outsiders to lead significant change initiatives.

These five basic assumptions are key elements of the organization's culture, particularly with respect to the objectives and challenges associated with the CTR Team and the CTR Program.

3.3 Approach

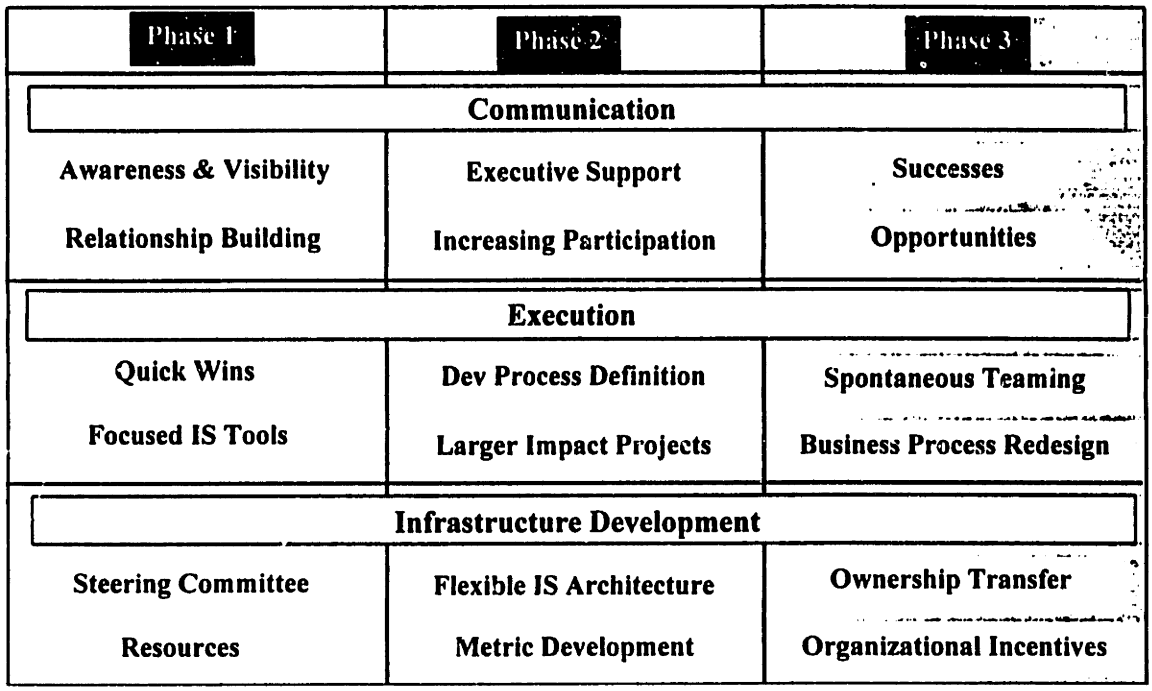
With bold objectives and a new charter, the CTR Team began reaching out beyond the factory environment to the product development community. This section will describe the team's approach to initiating and institutionalizing the CTR Program.

While the CTR Team's approach is evolving and will continue to evolve, the first year of the CTR Program can be categorized as a "skunk works" project being driven from the ground up. When the program began, there was little incentive for development engineering managers, materials managers, or manufacturing managers to participate or cooperate with the program. There was little, if any, support or awareness on the part of executive level management.

Having a reasonable awareness of the challenges facing the program, the manager of the CTR Team dedicated the majority of year number one to gathering resources, generating quick wins, and building organizational awareness. Gathering resources translates into hiring and indoctrinating a handful of individuals into the CTR Team. These individuals would be the coordinators and facilitators for a number of multi-functional improvement projects. The quick win projects were seen as a necessary prerequisite to asking for broad support among executive management. The last area of emphasis, building organizational awareness, was accomplished through a combination of personal selling and relationship building.

Figure 3.3.1 summarizes the high level approach adopted by the manager of the CTR Team. In the figure, phase 1 roughly translates to the first year of the program's existence. As shown, three key elements of the approach included communication, execution, and infrastructure development.

Figure 3.3.1 Phased Approach to CTR Initiation & Institutionalization



The communication element of phase one was accomplished primarily through word of mouth. All opportunities, particularly lunch meetings, were used to explain the new charter associated with the CTR Program. These one on one and small group interactions were also used to solicit ideas for improvement opportunities. Within the CTR Team, these ideas, particularly those from development engineering managers, were viewed as the voice of the customer.

The execution element of phase one concentrated on implementation of relatively small scale improvement projects. In this "present-focused" and "just try it" culture, quick wins were seen as a way of building support among the development engineering community. As a result, project content typically focused on satisfying immediate needs of development engineering managers. It is important to note that these managers are the individuals ultimately responsible for rapidly bringing products to market. Due to the skill set of the individuals within the CTR Team, the improvement projects all resulted in relatively focused IS (software) tools. These tools helped manage design information and enabled closer communication in the manufacturing phase of product development. Although there were different priorities among various product development groups, there was clear consensus in terms of the desire to streamline prototyping activities.

The third element of the CTR Team phase one approach focused on developing an infrastructure for the CTR Program. The development of infrastructure emphasized people, processes, and the environment. Three new CTR Team staff members were hired and trained. Processes internal to the CTR Program were defined. The bulk of these definitions concentrated on expectations, standards, and deliverables for the tasks

associated with leading and facilitating multi-functional process improvement projects. Late in the year, a steering committee was established for the purpose of setting priorities and resolving cross-functional conflicts. This steering committee consisted of senior level managers, one or two levels below executive management, from functional areas including development engineering, materials, manufacturing and MIS.

Phase 2 of the approach to CTR Program initiation and institutionalization, (shown in the center of figure 3.3.1), will correspond with the program's second year of existence. At the time this research ended, the second year of the program was just beginning. These elements illustrate various mechanisms the CTR Team will emphasize in transitioning from program startup (phase 1) to program maturity (phase 3).

The communication element of phase two will stress executive support and increasing program participation across the facility's many product development teams. One of the goals is to encourage and facilitate speeches, newsletters, and executive interviews. In terms of participation, the CTR Team will try to become early partners with product development teams as they are assembled for new projects. Eventually, more and more product development teams will have had the experience of partnering with CTR Team and improving the development process while developing products.

The execution element of phase two will focus on two areas. First, having established some credibility, the CTR Team feels comfortable in spending the time and resources necessary to generate a detailed process map for the entire product development process. By defining the "As Is" development process, the CTR Team will have a baseline starting point and a tool for communicating improvement opportunities. The CTR Team's second area of focus will be specific improvement projects with a larger cycle time impact, relative to phase 1 projects.

The infrastructure element of phase two will emphasize information systems and metrics. A key goal will be the development of a flexible IS architecture with clear responsibilities across the various IS support groups. Inclusion and consensus will be important considerations to ensure that the new architecture will become a roadmap for the future. A second important goal for the CTR Team will be to define and prioritize a set of metrics that will be used to track improvements and progress relative to the CTR Program. This effort also requires strategies for collecting accurate data in a minimally intrusive manner.

If the second phase of the CTR Team approach proves successful, then phase three will correspond to CTR Program institutionalization. It is hoped that this phase will be reached during the third year of the program's existence.

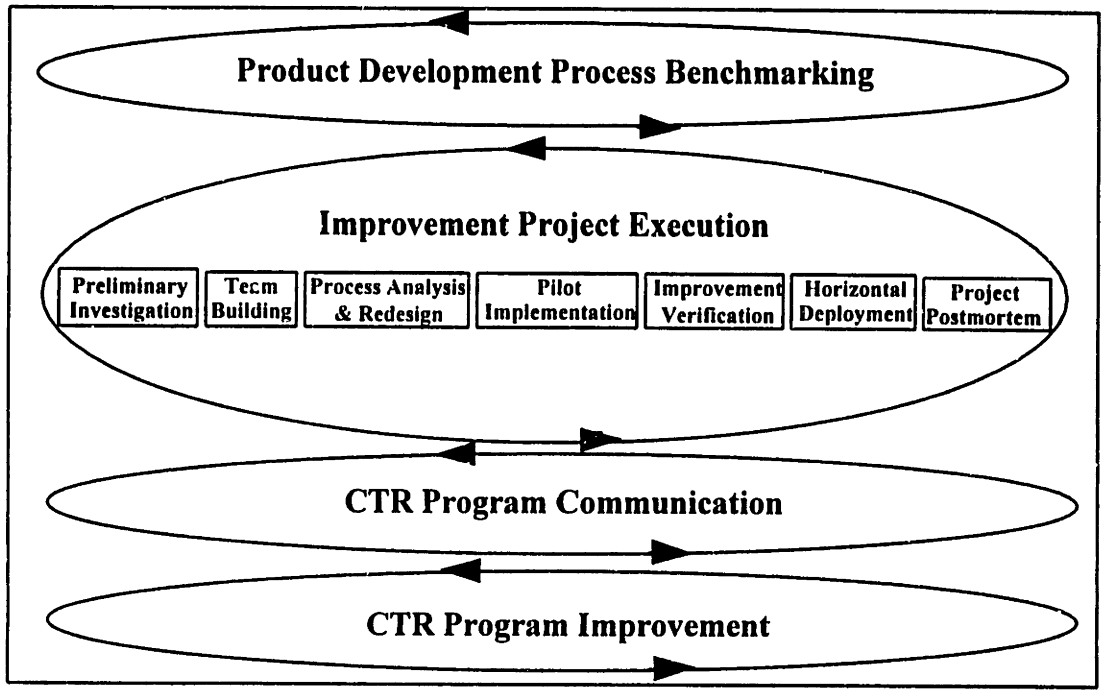
The communication element of phase three will hopefully include contributions from all levels of the organization. By that point, individuals at the highest and lowest levels of the organization should be familiar with the program's objectives and methodology. Ongoing communication mechanisms will focus less on CTR Program visibility/education and more on specific project successes and high leverage opportunities.

If the CTR Program becomes institutionalized, execution will consist of business process redesign carried out by spontaneously formed multi-functional teams. An important differentiator versus earlier phases is the new emphasis on business process redesign as opposed to the implementation of task specific IS tools. In addition, this phase of the program will hopefully be characterized by self-led teams that require little or no coordination or facilitation on the part of CTR Team staff members.

Infrastructure development in this third phase will also be different. The goal will be to transfer ownership of the CTR Program from the CTR Team to the Program Steering Committee. This will require the development of training materials for potential multi-functional team leaders. The content of this training would concentrate on facilitation skills, process mapping, and the principles of continuous process improvement. If successful, the CTR Program will also have a direct impact on the metrics used to judge the performance of development engineering managers and others involved in product development. A portion of an individual's evaluation will be based on her contribution to improvements in the process of product development as opposed to a single minded focus on product design.

Once the infrastructure is in place, the CTR Program will hopefully be characterized by the ongoing elements shown in figure 3.3.2. The program can be the focal point for continuous benchmarking of product development processes across the business, the corporation, and industry. In addition, the program will be an ongoing coordination mechanism for concurrent multi-functional improvement projects. (The core pieces of the project execution methodology shown in figure 3.3.2 will be detailed in chapter four.) Communication will always be a critical component of the CTR Program. And finally, it is important to recognize that cycle time reduction is a process in and of itself. Internal process improvement will be an ongoing element of the CTR Program.

Figure 3.3.2 Ongoing Elements of a Mature CTR Program



If the CTR Program is successful and cycle time reduction becomes a management philosophy rather than a silver bullet, the business will have an internal mechanism for renewal. Progress will have been made in the drive to become a learning organization - one that *intentionally creates, acquires, and transfers shared knowledge that is used as a basis for modifying behavior, generating desired results, and continually expanding the capacity to achieve its core purpose*[12].

3.4 Challenges

This section will describe the challenges facing the CTR Team and the CTR Program. To provide some level of differentiation, these challenges will be divided into two major categories: cultural and tactical. Significant barriers to positive change can be linked to specific aspects of the organizational culture. Additional challenges exist at a tactical level, particularly with respect to the *process* of cycle time reduction.

The basis for this organization's cultural challenges can be extracted from section 3.3.2. A case can be made that each of the five basic assumptions impacts the CTR Team's attempts to institutionalize the CTR Program. Before starting this discussion, it is helpful to review the central components of cycle time reduction listed in section 2.1:

- Systems Thinking/Process Focus

[12]This definition of a learning organization is a synthesis of ideas drawn from Peter Senge, Christopher Meyer, Nancy Dixon, and David Garvin.

- Tasks evaluated on the basis of value added to the external customer
- Open and direct information flow
- Few disconnects between functional boundaries
- Resources allocated to non-manufacturing process development
- Cost of time to market delays are factored into trade-off analyses
- Bottleneck management is applied to product development

It is also helpful to review the five basic assumptions:

1) Individual experience is valuable
2) The present matters most
3) Just try it
4) Individuals have a right to veto group decisions
5) The business has some of the best talent in the world

The first of these basic assumptions has an impact on the willingness of individuals to volunteer for multi-functional process improvement teams. This assumption also influences the effectiveness of those teams.

The second basic assumption has an impact on the approach that the CTR Team uses in trying to move beyond the initiation phase of the CTR Program. Because there is such a strong emphasis on the present, it is important for the CTR Program to deliver immediate benefits in the form of small successes. Notice that the CTR Team consciously decided to wait until phase 2, after it had some successes under its belt, before it formally began efforts to map the entire product development process.

The third and forth basic assumptions have an impact on the organization's willingness to accept common processes across factories or product development teams. Each development engineering manager has a unique style and special needs that sometimes conflict with standardization efforts. The demand for flexibility combined with a "just try it" philosophy and individual authority results in many unique patches that have been applied to troublesome aspects of the product development process.

The fifth and last basic assumption is an indication of a fairly strong not invented here syndrome. It will be important for the CTR Program to gain wide recognition as a business need as opposed to a CTR Team initiative.

Table 3.4.1 lists the cultural challenges facing the CTR Team and Program. For each central component of cycle time reduction, the table lists corresponding cultural elements that conflict in some manner. These challenges can be summarized by stating that the major barrier to progress is too much emphasis on product and production and too little emphasis on process and product development capability.

Table 3.4.1
Cultural Challenges Facing the CTR Team and Program

Central Components of Cycle Time Reduction	Conflicting Cultural Elements
Systems Thinking/Process Focus	Just try it
Tasks evaluated on value added to external customer	Individuals have a right to veto group decisions Just try it The business has some of the best talent in the world
Open and direct information flow	Individual experience is valuable
Few disconnects between functional boundaries	Individuals have a right to veto group decisions
Resources allocated to non-manufacturing process development	The present matters most
Cost of time to market delays are factored into trade-off analyses	Just try it
Bottleneck management is applied to product development	The present matters most

In addition to these cultural issues, the specific tactical challenges currently facing the CTR Team and the CTR Program are:

- Process mapping the entire product development process

  Before the CTR Team can move beyond "quick wins" and begin "larger impact" cycle time projects, it will be necessary to define the current product development process. This is no small task given the current level of flexibility enjoyed by development engineering managers. With many product development projects occurring at any one time, it will be difficult to describe a process that is specific enough to be useful as well as robust enough to include existing process variability. It will be particularly challenging in an extremely lean organization with visible disdain for "fluff work." Even if the CTR Team succeeds in defining a process with detailed tasks, inputs, outputs, and cycle times, the definition must be done in such a way that it is a useful communication tool. If the definition appears too complex, the development engineering community will ignore it and revert back to "gut feel" when identifying cycle time improvement opportunities. Without an effective process map, the likely result will be a series of stopgap improvement projects as opposed to root cause solutions.

- Developing, prioritizing, and institutionalizing a set of metrics for the program

  The product development community and the entire business are continually fighting bureaucracy. As a result, relatively few product development metrics are regularly tracked and used for performance evaluations. If the purpose of the metrics is to change behaviors, the CTR Program needs a small handful of prioritized product development metrics that can be applied across all product programs. What metrics should be tracked:

  - resources expended (labor hours) for common tasks?
  - cycle time for common tasks?
  - time to transfer product data between tasks or functional groups?
  - time spent acquiring signoffs and approvals?

  Even after a critical few metrics are selected, specific definitions and measurement standards need to be established for each metric. Executive management and senior level product development managers will need to step in and assume the responsibility for overcoming this challenge.

- Devising ways to track metrics in a development engineering environment

  Detailed time tracking is not a preferred activity for development engineers. It is time consuming and it can be perceived as insulting or demeaning. Unlike the shop

floor environment, the engineering lab does not have a tradition of process engineering and data collection. These types of challenges need to be considered up front when selecting and prioritizing a set of product development metrics. Although some metrics that can be tracked using automated design tools, an integrated measurement system needs to be designed in parallel with specific metrics. In addition, any system will need backing from upper management before it can be implemented and *used*. Without such a system, it will difficult for the CTR Program to show tangible improvement in cycle time for the product development process as a whole.

- Transitioning from "providing IS tools" to "improving business processes"

  The expertise of individuals in this group has traditionally been in the area of information systems. In order to appease the internal customers within the product development community, the CTR Team has focused on providing software tools aimed at managing and transferring product data within the prototyping phase of product development. As it matures, the CTR Program must begin to increase the scope of its specific improvement projects. More aggressive goals will be required in order to significantly reduce the time for overall product develoment cycle time.

Based on these challenges, it is highly possible that phase 2 of the CTR Program will be more difficult than phase 1. Fortunately, the program is gaining visibility among executive level managers.

3.5 Progress

For a "grass roots/skunk works" program being initiated by "outsiders," the CTR Program has made remarkable progress. In the program's first year of existence, three distinct improvement projects were conducted and each project resulted in the implementation and use of new software tools. These small successes were accompanied by increasing visibility (of the CTR Program) throughout the product development community. Elements of infrastructure have been established including the formation of a senior level steering committee as well as the formation of a task force for IS architecture. The CTR Team has even reached out to other businesses within the corporation to perform benchmarking studies in the area of cycle time reduction. As the first year was ending, the most important milestone was finally achieved - the business' general manager stated that the CTR reduction in product development cycle time was a critical *business need*.

One of the first year's improvement projects associated with the program focused on bill of material management. As a structured list of components for a product, the bill of material is a critical source of information that is used across functions and tasks throughout the development process. Due to an incremental evolution in the business' information systems, there are multiple versions of a bill of material. During the early phase of product development, it is critical that engineering BOM updates are reflected in the factory's material control/MRP system. In the past, this batch update process had a

cycle time of *weeks*. As would be expected, there were frequent disconnects within this process. The CTR Team's improvement project improved this scenario by reducing the cycle time for BOM updates.

A second improvement project associated with the CTR Program focused on the process for ordering product specific materials and tools. Due to the large number of incorrect tools that were being received and the resulting delays in factory builds, an individual within the CTR Team formed and led a multi-functional problem solving team. This team included individuals from the engineering community, manufacturing engineering, and suppliers. Together, the team defined their current order process and identified improvement opportunities. Hard copy faxes, often lost in a factory environment, were eliminated from the process. A major information silo was eliminated and a multi-functional process was streamlined. This was accomplished without purchasing any new computer hardware. This project is currently being piloted and it will be rolled out to later this year.

The third improvement project associated with the first year of the CTR Program will be the subject of chapter four.

3.6 Recommendations

This section will suggest a number of program specific recommendations. Instead of detailed issues related to project execution, these recommendations will focus on the CTR Program as a whole. It will be assumed that the CTR Program is the business' primary mechanism for driving and coordinating cycle time reduction in product development.

Prior to making specific recommendations, it is important to put the key challenges from section 3.4 into perspective. Summarizing those challenges, the business' major barrier to positive change is *too much emphasis on product and production and too little emphasis on process and production capability*. The quick wins generated during phase one of the CTR program have highlighted significant opportunities for horizontal learning within the product development community. However, the development engineering organization is focused on product elegance. Wins and losses are associated with individual talent rather than organizational capability or infrastructure. A disdain for structure and a "just try it" mentality lead to pockets of suboptimized excellence. Very few individuals are looking at the entire product development process and searching for improvement opportunities in the "white space" between functional groups. In reality, the cultural focus on the present discourages efforts to build long term capabilities such as multi-functional teaming or consistent procedures. Although this business is very profitable, opportunities for improvement do exist.

3.6.1 Program Fit

In maturing from initiation to organization-wide institutionalization, the CTR program should be molded such that it utilizes the strengths of the organizational culture:

- *Develop a core group of line champions that can help pull improvement projects*

In this business, there are very few infrastructural incentives that encourage participation in multi-functional problem solving teams. However, informal incentives can be very powerful in this environment. In particular, some line managers have earned wide-ranging respect from their peers within and across their functions. This respect allows these individuals to deliver results that would otherwise be remarkable. Although it is easier said than done, the CTR Program needs to develop a cadre of these respected managers that will serve as champions/sponsors for specific multi-functional improvement projects. As team sponsors, these managers can encourage others to volunteer and remain committed to achieving the goals of specific projects. These individuals have enough informal power to influence behaviors.

Referring back to figure 3.3.1, the importance of quick wins should now be more evident. In order to get these influential line managers "on their side," the CTR Team needed to offer something in exchange. For the line managers, focused IS tools were a tangible benefit that reduced human resources expended and cut sub-process cycle times. In trying to build the necessary relationships, the CTR Team realized up front that talk is cheap - especially when it is coming from "outsiders." In the absence of stronger support from upper management, additional wins, ongoing communication, empathy, and patience should be key pieces of a strategy to develop a core group of line managers willing to champion specific improvement projects.

- *Emphasize horizontal deployment following pilot implementations*

A key role for the CTR Program is organizational leverage. The organization's "just try it" culture facilitates pilot implementations of improvement projects. However, the real challenge comes in trying to spread best practices from one product development team to another. True leverage comes from the ability to ensure that identical problems don't get solved 50 different times in 50 different ways.

As a CTR Team member facilitating a multi-functional problem solving team, it is easy to be satisfied when a pilot implementation proves successful. At that point, the quick win has been achieved. In this environment, however, a successful pilot does not guarantee immediate willingness to change on the part of other product development teams. Personal selling becomes extremely important when it comes time to deploy an improvement across the organization.

In the past, a successful pilot has often corresponded with a transfer of leadership in a process improvement project. In this environment, the lead facilitator from the CTR Team has been expected to move on to bigger and better challenges once an improvement has been piloted. Responsibility for rolling out the improvement is then assigned to an individual from a support group (either internal training or IS support). This new individual, typically uninvolved in the early stages of the project, is then

expected to go from one installation to another making sure the improvement is implemented and executed correctly. A natural gap in knowledge and commitment makes the job of personal selling all the more difficult, particularly when the individual from internal training or IS support does not anticipate the organizational resistance that must be overcome.

There is a dilemma here because there will always be new problems that need to be solved (i.e., projects to be facilitated by the CTR Team). However, there may be value in the concept of cradle to grave project management/facilitation. By maintaining uniformity of leadership and accountability, horizontal deployment will likely be a more effective element of the CTR Program.

- *Provide wide recognition of individual contributors*

Although there is little organizational support for multi-functional teaming, the CTR Team has been able to identify a number of individual "thought leaders" that are willing to step back from their functional perspectives and make personal sacrifices, usually overtime, to help eliminate disconnects in processes that span functional boundaries. Some of these individuals have gone so far as to hide their team participation from direct supervisors.

When multi-functional problem solving teams deliver tangible benefits to the organization, it is important that *individuals* are recognized for their contributions. If these individuals can be made into "heroes", participation in future projects will be more forthcoming.

This recognition is also important when it comes time to roll out pilot implementations across product development teams or factories. Improvements are easier to sell when solutions are recognized as being conceived by insiders.

The CTR Team has recognized its role in providing this recognition and it is working hard to ensure that credit is received where it is due.

It is also important to avoid tools and techniques that run counter to the organizational culture:

- *Avoid paralysis by analysis*

In this organization, progress is measured by tangible results. When an improvement opportunity is identified, some preliminary investigation is useful. However, it does not make sense to specify deliverables and delivery dates prior to the formation of a team and prior to the point at which the team reaches consensus in terms of an implementation plan. The program should not be run as a consulting engagement. In the early stages of project execution, documentation, planning, and analysis should be

minimized and used primarily as a tool for promoting common purpose and understanding within multi-functional teams.

3.6.2 Infrastructural Mechanisms

For the CTR Program to become institutionalized, there will also need to be infrastructural means of encouraging process focus and systems thinking. Several suggestions are described below:

- *Include process related metrics in individual performance goals*

  The existing metrics do not encourage process focus or systems thinking. It is possible that the metrics being used are the wrong metrics. If the CTR Program is to be successful, individual performance reviews must include metrics that encourage more of a balance between production and production capability. The following steps should be followed in modifying the existing measurement system:

  - Define the desired behaviors (cycle time, defect reduction, etc.)
  - Define measures for each behavior
  - Prototype the modifications (adverse impacts? desired behavior?)
  - If successful, implement the modifications

  These steps need to be completed by executive management as opposed to the CTR Team.

- *Promote process related recognition forums*

  Benchmarking across the corporation revealed one business that requires process improvement teams to make regular presentations to an executive steering committee. During these presentations, the multi-functional teams report on progress and identify implementation barriers that require management attention. It is no coincidence that that business has a mature and effective Cycle Time Reduction Program.

  In an extremely lean environment where promotions are based on tenure as well as merit, well organized recognition forums can provide individuals with the incentive to participate in multi-functional problem solving teams.

- *Conduct a coordinated communication campaign*

  Like "total quality management" or "re-engineering", "cycle time reduction" has value as a communication tool. To increase the effectiveness of this tool, it is important to put together a coordinated communication campaign that spans multiple mediums and includes inputs from all levels within the organization. Program updates can be communicated via newsletters, bulletin boards, brown bag lunches with senior management, and a variety of other means. If the message is consistent, repetitive,

and associated with the goals of executive management, the CTR Program will gain critical visibility.

3.6.3 Leadership Opportunities

Does executive management have the desire to focus on making the CTR Program successful? Is the program one of the top five initiatives for the organization and its leadership? If not, it is unlikely that the CTR Program will become institutionalized and it is unlikely that CTR Team will gain the authority to redesign business processes. In addition to verbally supporting the program, executive and senior level management needs to dedicate time and energy to implementation. Several leadership opportunities are described below:

- *Link cycle time reduction to process improvement and organizational learning*

  It is important that cycle time reduction is not perceived as another term for working harder. Business leaders need to continually reinforce the message that cycle time reduction is a simple philosophy that focuses organization-wide attention on processes and working smarter. Cycle time reduction should be directly linked to continuous process improvement and the competitive advantage generated by organizational learning. It is not sufficient to have this message be delivered by individuals within the CTR Team.

- *Participate actively*

  Each of the recommendations described in section 3.6.2 require action on the part of executive management. At some point, leadership by example is required:

  - Strive to reduce or eliminate cycle times for management approvals and signoffs

  - Make personal appearances at recognition forums a high priority

  - Develop and implement a modified performance system

  - Write newsletter articles, hold brown bag lunches, and deliver speeches

  - Sit in on steering committee meetings for the CTR Program

  These are some very tangible contributions that executive management can make.

- *Enforce team accountability*

Katzenbach and Smith[13] provide a clear description of the difference between working groups and teams:

Working Group: Members interact primarily to share information, best practices, or perspectives and to make decisions to help each individual perform his or her area of responsibility.

Team: A small number of people with complementary skills who are *equally committed to a common purpose, goals, and working approach for which they hold themselves mutually accountable.*

Effective teaming doesn't automatically happen when a group of people are assigned to a problem. To facilitate effective teaming, the business' leaders need to enforce accountability among members of teams participating in the CTR Program. One alternative is to require process improvement teams to make regular presentations to an executive level steering committee. Clearly, there needs to be an active steering committee for this to occur.

This section has described some ways that executive management can contribute to the success of the CTR Program. In general, this business' leaders can help by increasing the organizational focus on process and production capability rather than product and production.

In seeking this type of management support and participation, the CTR Team can play an important role as it embarks upon phase two of the CTR Program. The CTR Team needs to generate widespread problem recognition by engaging in activities such as executive education, competitive benchmarking, site visits, supplier feedback, and external customer feedback. Despite the small successes that have been generated, the CTR Program will remain a relatively low priority unless the majority of senior managers recognize the opportunities for improvement within their own product development process.

[13]Joh Katzenbach & Douglas Smith. The Wisdom of Teams: Creating the High-Performance Organization. Harvard Business School Press. Boston, MA. 1993.

4 Implementing Cycle Time Reduction - A Specific Project

This chapter will step down from the program level and attempt to characterize cycle time reduction at a project level. As with the previous chapter, the goal is to translate the author's direct experience into a learning history with generalizable lessons.

4.1 Project Description

In this case, the multi-functional process improvement project targeted material management within product development. It is considered one of several high leverage sub-processes within the factory build cycle. Material management incorporates the procuring, receiving, inspecting, gathering, packaging, staging, and tracking of parts. Hundreds of electrical parts and mechanical parts must come together in the proper packaging at the right time.

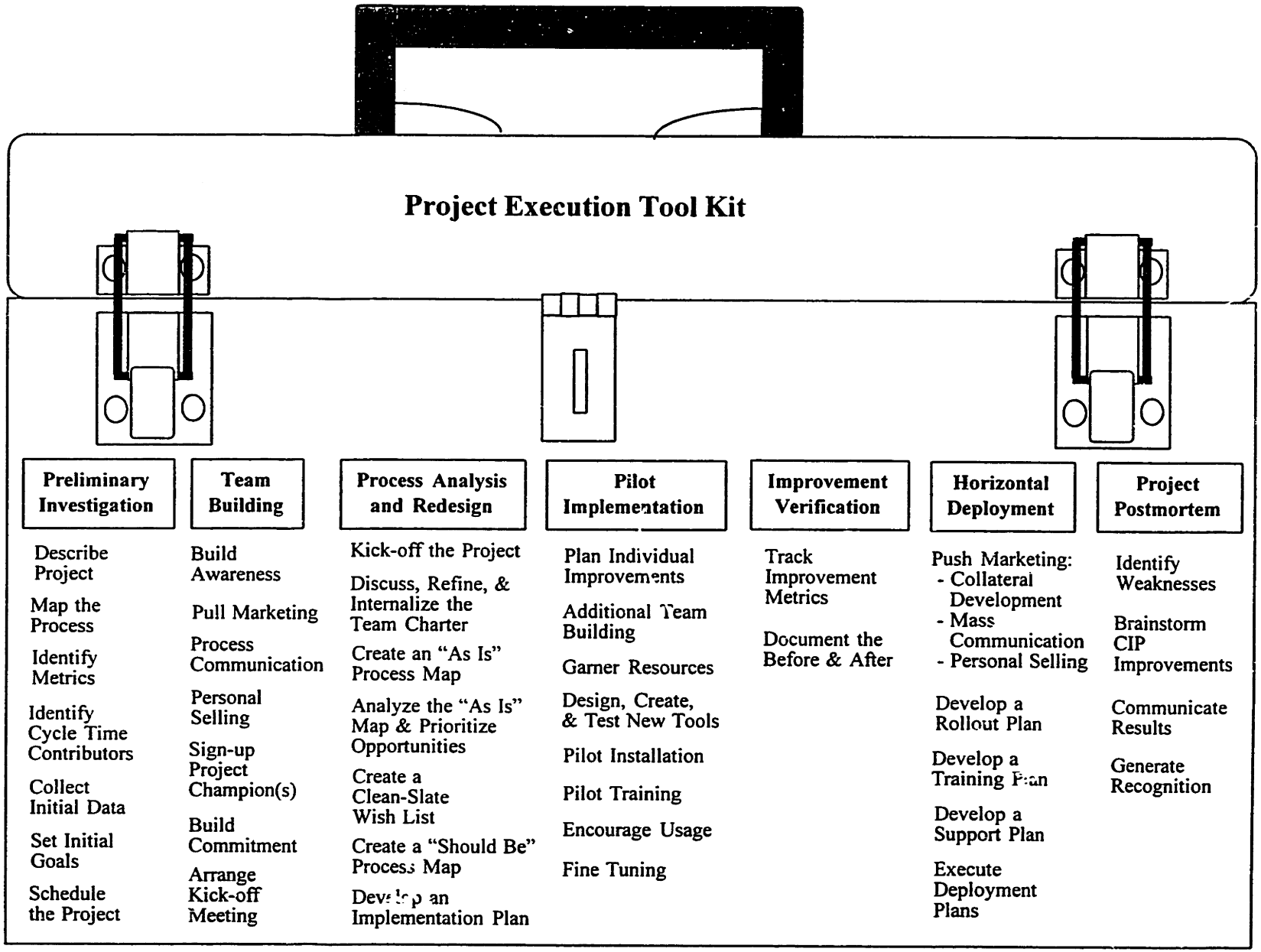
The project was initiated at the request of several development engineering managers that were being courted by CTR Team as part of efforts to initiate the CTR Program. These managers had been experiencing a chaotic process characterized by frequent defects requiring significant resources and time. In addition to the time spent chasing lost material, the process defects often resulted in closed windows of opportunity. The manufacturing community schedules specific time windows for development engineering to build their products. If that window closes without a build being completed, development engineering must wait up to a week before rescheduling their build. Clearly, the process defects are capable of delaying the overall schedule for a product program.

4.2 Approach & Execution

At the time this project was conducted, the project execution methodology shown in figure 3.3.2 was still evolving. Although the sequence of stages from preliminary investigation to project postmortem was fairly straightforward, there was very little structure in terms specific tasks within a given stage. That lack of structure proved to be valuable in this product development organization.

Given the premium placed on flexibility within this organization, the most effective way to describe the approach is to use the analogy of a toolbox. Figure 4.2.1 depicts a generic tool kit of project execution tasks. Throughout the material management project, it was necessary to customize some tasks, and skip others altogether. In general, however, the project followed a roadmap starting with the tasks in the upper left hand corner and ending with tasks in the lower right hand corner of figure 4.2.1. The details of that journey will be described below.

Figure 4.2.1


Project Execution Tool Kit
Preliminary Investigation
Describe Project
Map the Process
Identify Metrics
Identify Cycle Time Contributors
Collect Initial Data
Set Initial Goals
Schedule the Project
Team Building
Build Awareness
Pull Marketing
Process Communication
Personal Selling
Sign-up Project Champion(s)
Build Commitment
Arrange Kick-off Meeting
Process Analysis and Redesign
Kick-off the Project
Discuss, Refine, & Internalize the Team Charter
Create an "As Is" Process Map
Analyze the "As Is" Map & Prioritize Opportunities
Create a Clean-Slate Wish List
Create a "Should Be" Process Map
Develop an Implementation Plan
Pilot Implementation
Plan Individual Improvements
Additional Team Building
Garner Resources
Design, Create, & Test New Tools
Pilot Installation
Pilot Training
Encourage Usage
Fine Tuning
Improvement Verification
Track Improvement Metrics
Document the Before & After
Horizontal Deployment
Push Marketing:
- Collateral Development
- Mass Communication
- Personal Selling
Develop a Rollout Plan
Develop a Training Plan
Develop a Support Plan
Execute Deployment Plans
Project Postmortem
Identify Weaknesses
Brainstorm CIP Improvements
Communicate Results
Generate Recognition

4.2.1 Preliminary Investigation

As the CTR Team facilitator responsible for this project, the author was responsible for completing the tasks listed under the preliminary investigation stage. At this point, there was no team associated with the project. Throughout this stage, the facilitator's primary goal was to become as knowledgeable as possible while preparing for the team building stage of the project. It required roughly six weeks to complete the preliminary investigation stage.

Describe Project: The facilitator clarified his understanding of the project by completing a one-page document describing an objective, target metrics, and potential deliverables. Looking back, too much emphasis was placed on this document and it would have been better to complete this task as one of the last tasks in the preliminary investigation stage.

Map the Process: The facilitator interviewed individuals from the various functional areas and gradually pieced together a map of the entire process. The map included estimated cycle times for various steps in the process.

Identify Metrics: The facilitator developed detailed metrics for cost, quality, and cycle time associated with the project:

Cost:

Production Materials Efficiency:
Percentage of material handling hours spent on value-added activities

Development Engineering Resources Expended:
Development engineering hours spent managing materials

Material Management Resources Expended:
Material Management hours spent procuring, receiving, and inspecting material

Quality:

Procedural Consistency:
Number of hours (per build cycle) spent managing exceptions

Cycle Time:

Factory Build Days:
Time to complete a build cycle

Going through the process of developing these metrics gave the facilitator a better understanding of the process he was trying to improve. However, the specific metric definitions did not prove useful in the latter stages of the project. This is because there was no system by which these metrics would be recorded or tracked. Individuals were "too busy" to keep track of data such as this.

Identify Cycle Time Contributors: Based on initial interviews with various functional individuals, the facilitator put together a list of cycle time contributors. Examples include:

1) Shortage analysis requires factory specific vs. facility wide information
2) Part status information is unavailable on-line
3) The process crosses organizational boundaries & lacks an "owner"
4) Lack of discipline leads to the need for frequent cycle counting
5) Parts are stored in multiple areas
6) Poor visibility of incoming parts in receiving
7) Poor visibility of incoming parts in inspection
8) Temporary part numbers can't be tracked on the material control system

This was essentially a first cut at a problem list. It was a useful starting point in latter efforts to form the multi-functional improvement team.

Collect Initial Data: Since functional individuals rejected the idea of recording detailed cost, quality and cycle time information, the facilitator did his best to pull together and verify ranges of cycle times for each of the process steps.

Set Initial Goals: Knowing there was a six month limit to the research project, the facilitator attempted to lay out some stretch goals for the improvement project. Instead of it requiring an average of a few weeks to prepare the materials for a physical build, it would hopefully take less than one week after the improvement project was completed.

Schedule the Project: The facilitator put together an estimated time line for the remainder of the improvement project. The estimates included begin and end dates for each of the seven stages shown in figure 4.2.1. Having a fixed end date (end of research project) helped limit the scope of the project and make this scheduling task easier than it would have been without a fixed end date.

4.2.2 Team Building

During this stage, the primary objective was to form a multi-functional team *with the ability to overcome implementation barriers later in the project.* Most of the tasks called for one on one meetings between the facilitator and potential team members. It required nearly four weeks to complete the team building stage of the project.

Build Awareness: The facilitator went "door to door" throughout the facility introducing himself and describing some of the findings from the preliminary investigation stage of the project. During the course of these introductions, individuals from various line and support functions often received their first exposure

to the CTR Program. This task built awareness of the overall program as well as the specific improvement project.

Pull Marketing: Pull marketing is a term that reflects attempts to solicit the voice of the customer in the development of a process or product. In this case, the customers were internal and the process was material management. Individuals involved in the process were asked for improvement ideas. The ideas usually came in the form of descriptions of what is wrong with the current process. Individuals were not asked to volunteer for the team at this point. That request would come later.

Process Communication: This is a task that has no end point. It refers to an ongoing effort to focus on the process as opposed to individuals when discussing problems or opportunities. As a neutral party, the facilitator attempted to lead by example and encourage individuals to employ systems thinking and de-personalize issues that arose. It required a conscious evangelical effort to "speak the new language of the CTR Program."

Personal Selling: This is another task that has no end point if the CTR Program is to become institutionalized. It begins when the facilitator begins asking for project champion(s). It is as simple as believing in the objectives of the project, asking for help, and remaining committed throughout. Personal level of commitment is something a facilitator cannot hide from team members.

Sign-Up Project Champion(s): This is a critical task in terms of building a team that will be able to overcome implementation obstacles. The project champion is a team member that acts as figurehead and cheerleader. It is important to identify individuals that have enough organizational clout to build consensus and provide resources when it comes time to implement changes. For this project, a well respected manufacturing manager and a well respected factory materials manager agreed to act as co-champions. The co-champions became the first two members of the material management team. Both played a major role in recommending additional team members and then convincing them to participate. For example, it was the manufacturing manager's idea to include a representative from MIS on the team.

Build Commitment: In this task, the facilitator formed the remainder of the material management team. In addition to the co-champions and the facilitator, the initial team consisted of:

From Manufacturing:	2 manufacturing engineers
From Materials:	1 factory materials manager
From Purchasing:	The manager responsible for product programs
From Inspection:	The senior manager for supplier quality control
From Engineering:	2 lead managers (from separate product programs)
From MIS:	1 manager

Most of these individuals agreed to participate out of kindness more than anything else. It did help that their initial commitment was limited to the process analysis and redesign stage of the project. Amongst the team members, there was initially a great deal of doubt whether the project would actually lead to any changes. Multi-functional problem solving teams had little history of success in this organization.

Arrange Kick-Off Meeting: By polling the various team members, the facilitator made sure there was a time when everyone could be present for the official project kick-off. If only half of the members had attended the initial team meeting, the project would have been doomed from the start given the prevailing attitude towards problem solving teams. To eliminate this possibility, it was important to get verbal commitments in person from each team member.

4.2.3 Process Analysis and Redesign

This was the key analytical stage of the project. The team's objective was to define desired changes in the process and develop a corresponding implementation plan. Because the project had a fixed deadline (at the end of the six month research project), the team found it relatively easy to contain the scope of potential improvements. This stage consisted of weekly team meetings, once a week, for six weeks.

Kick-off the Project: The very first team meeting was a symbolic project kick-off. During this meeting, the facilitator summarized the results of his preliminary investigation and he related the material management project to the larger cycle time reduction program. Fellow team members were introduced to each other. The facilitator laid out a roadmap of planned tasks the team would be completing during this stage. In addition, the facilitator distributed an initial "charter" for the material management team (figure 4.2.4.1).

Figure 4.2.4.1 The Initial Project Charter

August 17, 1994

Material Management Project
Team Charter

I. Mission

Within three months, this team will eliminate three of the top five cycle time contributors in the material management process.

II. The Material Management Process

The team will focus on the process of procuring, tracking, gathering, and staging parts for factory builds. Tactically, the actual cycle will be defined as the time from BOM freeze to complete parts staging. Strategically, it will be important to consider how this process affects the business' ability to complete build cycles within product development. It will also be important to consider how this process affects the business' ability to ramp up when products move from pilot to production status.

III. Goals

1. Clearly defined process with distinct ownership of multi-functional tasks
2. Signifcant reduction in cycle time

IV. Scope

The scope of this project will be driven by the team's ability to implement specific changes before November 30th, 1994. The efforts should focus on the material management process as defined above.

Discuss, Refine, & Internalize the Team Charter: This is a task that we did not complete as a team. As a result, we operated much more like a working group than a team. Individual team members did not feel accountable for accomplishing the project goals. The project became the responsibility of the facilitator. Project members, even the project champions, felt that attendance at weekly meetings fulfilled their obligations. Looking back, it would have been helpful if the team had been expected to give a group presentation to the CTR Steering Committee. Unfortunately, there was no such committee at the time.

Create an "As Is" Process Map: By working together to develop a map of the current process, the team created a collective, thorough, and tangible picture much different than anyone could have completed individually. The primary benefit of this task was the generation of a common understanding amongst the team. The team had a

common starting point from which to begin its analysis of disconnects and non-value added tasks. Figure 4.2.4.2 is a simplified replica of the wall size map created by individual team members. On the wall size map, task descriptions were written on self-adhesive yellow note paper. These "yellow stickies" were then attached to the map, one by one, from left to right, by the team member most familiar with a given task. As each task was added, a description was given to the team and discussion was encouraged. Inputs, outputs, and cycle times were included in descriptions of individual tasks. Prior to the mapping session, most team members were unaware of all the tasks within the process. It required two separate one-hour meetings for the team to complete the "As Is" process mapping.

Figure 4.2.4.2
Product Build Material Management Process Map
(Page 1 of 2)

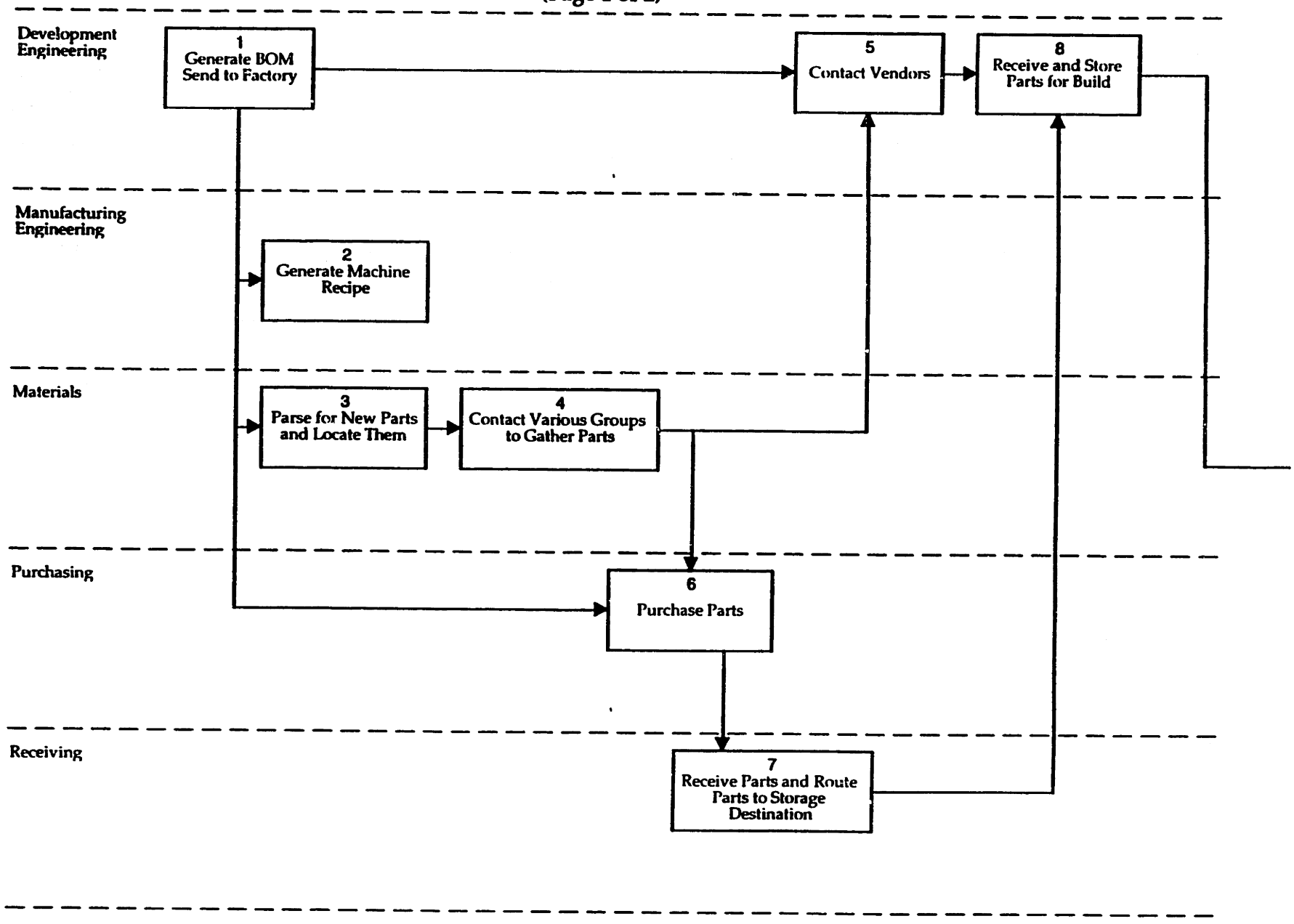
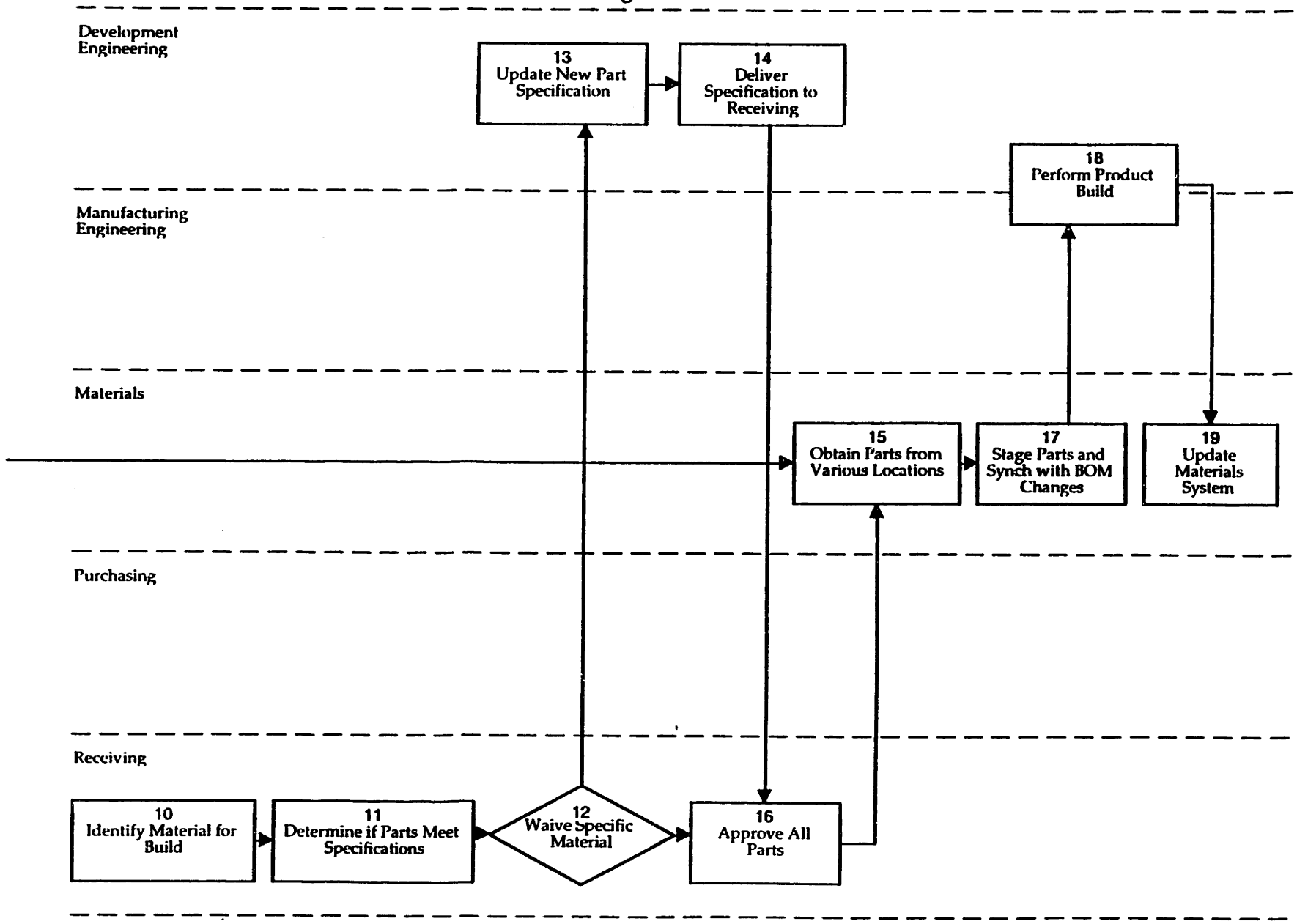


Figure 4.2.4.2
Product Build Material Management Process Map
(Page 2 of 2)



Analyze the "As Is" Map and Prioritize Opportunities: In this task, the team simply walked through the "As Is" map from left to right identifying waste within the process. The output from this meeting was a list of problems very similar to the list of cycle time contributors shown in section 4.2.1. The difference in this case was the fact that the list was generated by the team instead of by the facilitator.

Create a Clean-Slate Wish List: In the one hour meeting used to complete this task, all team members were asked to contribute a personal "I Wish" list of potential process innovations. Instead of a find and fix mentality, the team used a re-engineering approach to idea generation. Examples from that list include:

- One and only one accurate bill of material
- Eliminate back-door purchasing of material
- "Instant" official part numbers (trackable by the material control system)
- Guaranteed delivery of material
- All electrical parts packaged for auto-placement from day 1
- All unique material should bypass incoming inspection
- Automatic generation of a "chase list" for parts not available in the build factory

Create a "Should Be" Process Map: This was one of those tasks that the team consciously decided to skip. After four weeks of analysis, the team felt that there were enough improvement ideas on the table and that it was time for the facilitator to begin making changes. This was a reasonable decision given the fixed deadline for the project. However, in contrast to the spirit of plan-do-check-act, this meant that there would not be a standard definition for the improved process. The team elected to take a short-cut.

Develop an Implementation Plan: The facilitator developed a preliminary implementation plan and distributed it to the entire material management team.

The team's sign-off on the implementation plan marked the end of the process analysis and redesign stage of the project

4.2.4 Pilot Implementation

In theory, this stage of the project should have been a time when the team broke up and individual members took responsibility for implementing the specific improvements from the implementation plan. Other than the project facilitator from the CTR Team, each team member had full time job responsibilities that did not disappear just because there were improvements to be implemented.

To address this issue, the facilitator pared down the list of improvements and approached each one as a mini-project. Based on the remaining time available and a desire to show

tangible change, the facilitator chose to coordinate just two improvements. One of these improvement was:

- **The Factory Specific Shortage Report**

  The concept for this improvement was to provide a means of reducing the time required to perform shortage analysis for factory builds. The means would be provided in the form of a computerized report program that could be executed on-demand by material handlers within each factory. For this computer generated report program to be useful, the key would be accessibility and ease-of-use.

  The original process for performing material specific shortage analysis required up to four days of cycle time. Typically, the process would begin when a development engineer electronically transferred a copy of the latest BOM to a manufacturing engineer in the factory scheduled to perform the build. This manufacturing engineer would use this BOM to generate a complete parts list in hard copy format. This hard copy parts list would then be given to a material handler from the same factory (note: there are several separate factories under one roof at this facility). Over the course of several days, this material handler would then work his way down the parts list checking to make sure that the build factory had sufficient quantities of each part. This checking was done one part at a time by using a query screen within the computerized material control system.

  This tedious process was required because the material control system did not have the ability to generate a factory specific shortage report. A legacy system developed years ago, the material requirements planning system was capable only of generating a facility wide shortage report. This goal of this improvement was to enhance the existing system by developing a report that highlights those parts where the *quantity needed* (for an upcoming build) exceeds the *quantity on-hand* (in the specific build factory).

  The new report program was designed to change the process of performing shortage analysis such that:

  The Material Handler:
  - Asks the manufacturing engineer for the name and directory of the electronic BOM file (corresponding to the product to be built)
  - Double clicks on an icon to start the report program
  - Enters the number of physical products to be built
  - Enters the location code corresponding to the build factory
  - Enters the name and directory of the electronic BOM file

  The Program:
  - Checks available inventory by location code
  - Flags factory specific part shortages

- If the parts are available in other locations, identifies those locations and the corresponding quantities available
- Summarizes the shortage analysis in electronic spreadsheet format (which is easy for the user to modify and print out to hard copy)

While coordinating pilot implementations of these two improvements, the following tasks were executed:

Plan Individual Improvements: For both improvements, an initial project plan was developed. These plans detailed the following:

- Description of the business impact
- Description of the risk to the business
- Stakeholders affected
- Anticipated resistance
- Approvals required
- Scheduling priorities and dates
- Technical requirements

Additional Team Building: Small teams of key functional experts were brought together for the detailed design of these two improvements. The teams included individuals that would ultimately be affected by the pilot implementations. Material handlers helped design the factory specific shortage report and the quality control manager helped design the enhanced receipt routing for material.

Garner Resources: Both of these improvements required technical changes in the form of software development. In soliciting the expertise of specific software engineers, it was fortunate that an MIS manager had been participating from the beginning of the material management project. The MIS community was extremely cooperative throughout pilot implementation and the remaining stages of the project.

Design, Create, & Test New Tools: Based on inputs from various functional experts, the project facilitator documented the detailed designs for these two improvements. After review and approval by the functional users, the detailed designs were used by software engineers to develop the actual software code. Then, once the code was complete, the facilitator (acting as a liaison between MIS and the functional experts) developed and completed acceptance tests for each improvement. Although the software engineers did their own testing, it was useful to have an "independent" person that was not functionally-biased perform the actual acceptance testing. Acceptance testing identified a number of gaps between the functional user's initial design and the first revision of the software. Once identified, the missing or incorrect functionality was quickly fixed by the software engineers. This task was completed in less than two weeks.

Pilot Installation: Due to previously existing computer networking capabilities, the pilot installations were fairly straightforward and no new hardware was required. The tasks included:

- Set-up of new user accounts on several computers
- Installation of an automated networking protocol
- Installation of new software

It is worth noting that pilot installation required no effort on the part of functional users. Both MIS and the project facilitator made a conscious effort to avoid disruption of existing business activity.

Pilot Training: Because up-front installation efforts had been completed, functional users (only one or two during this pilot stage) were trained at their own work stations using their own computers instead of using a sterile training room with unfamiliar computers. The pilot training was conducted in one-on-one sessions between the project facilitator and the functional users. The combination of individual attention and a familiar environment increased the effectiveness of the training effort. Included in this effort were custom user manuals and quick-reference guides developed by the project facilitator and available on-line.

Encourage Usage: For the organization to realize the benefits of these improvements, usage is a key requirement. Unless the improvements are incorporated into the daily activities of the product development community, cycle times will not be reduced. As a result, it important that the project facilitator be available to walk individuals through new processes in the midst of actual scenarios as opposed to hypothetical examples. This face-time reduces uncertainty for individuals involved in the process. It also focuses attention on the benefits of the new and improved process. Each instance of new process effectiveness builds momentum for subsequent roll out efforts across the organization.

Fine Tuning: By following up and being present to encourage the use of a new process, the facilitator can identify subtle opportunities to fine tune procedures or technology. Issues that did not come up in design can sometimes be resolved with minimal effort. Early fine tuning facilitates subsequent roll out efforts. This is a key aspect of the learning that pilot implementations should provide. To make use of this learning, however, it is important to plan for fine tuning. Otherwise, schedules will slip and individuals such as software engineers will resist making additional changes.

4.2.5 Improvement Verification

This stage of the project is essentially a follow-up period corresponding to the "check" phase of the plan-do-check-act cycle. The changes implemented during pilot implementation should be reviewed and the new process should be measured to ensure that the modifications are creating the desired effect. For a number of reasons, however,

that did not happen in the case of this project. One issue was the fact that the initial team never completed a "Should Be" process map. Another issue was the organization's general aversion to detailed time tracking. Due to these issues and the overall satisfaction on the part of those involved in the pilot implementation, the facilitator minimized the resources spent in completing the following tasks:

Track Improvement Metrics: This facilitator completed this task by asking for estimates of the time saved due to enhanced receipt routing for material and due to the use of the factory specific shortage report. There was no rigorous tracking of the cost, quality, and cycle time metrics defined in the preliminary investigation stage of this project.

Document the Before and After: This task would typically be used to justify the resources spent on this cycle time reduction project. However, there was no steering committee to which the team was accountable. The minimal documentation that was completed in this task was used as a "sales tool" later in the horizontal deployment stage of the project.

4.2.6 Horizontal Deployment

This was the stage in which this cycle time reduction project became more than a continuous improvement project. Because the project was part of the CTR Program as opposed to an ad hoc problem solving effort, there was incentive to deploy the two process improvements across all factories and multiple product development teams. The project facilitator knew that horizontal deployment of pilot improvements would be an important criteria for success and a tangible justification (quick win) for the entire CTR Program. The tasks involved in making that happen are described below:

Push Marketing: This task can be conceptualized by imagining there is a product that needs to be pushed into the marketplace. In this case, the marketplace was the factories and product development teams that did not participate in the initial pilot implementations. The idea was to bring a marketing approach to technology development (the new software tools) and process improvement (shortage analysis and receipt routing for material). Brightly colored collateral (i.e., sales brochures) was developed and distributed to potential roll-out customers. This collateral was also used to generate recognition for the initial team members on the Material Management Team as well as the "special contributors" that designed the specific improvements. In addition, a large electronic mailing list was used to conduct a mass communication campaign extolling the savings in cycle time and resources after the pilot improvements were completed. Finally, one-on-one personal selling was used to convince engineering managers and material handlers to adopt the new processes and tools.

Develop a Rollout Plan: After completing the prior marketing effort, the project facilitator had a better idea of what parts of the organization would be implementing

the team's improvements. This information was used to put together a formal rollout plan with target dates for delivering the new tools/processes to specific individuals and groups. This plan served as a useful tool for managing the expectations of those waiting for installation of the factory specific shortage report and for instructions on how to facilitate direct dock-to-stock routing for unique factory build material.

Develop a Training Plan: By having a formal training plan, the project facilitator can justify a piece of the up front investment required to make the horizontal deployment a success. If a formal training plan is not documented, it becomes tempting to skimp on the development of training materials and programs. In the case of the factory specific shortage report, the training plan included lists of documentation to be distributed to each user. That plan also scheduled one-on-one sessions for the project facilitator to provide hands on training to those included in the roll-out plan.

Develop a Support Plan: In technology development and process improvement, installation and training are necessary but not sufficient. Someone needs to be available when users have difficulty using a new software tool or when users are confused by a new process flow. This is a critical need that the project facilitator must fulfill either personally or through the use of specific support resources. In the case of the factory specific shortage report, a formal arrangement was made so that the software engineer who wrote the actual code would be the primary point of contact if users had any questions or difficulty. Included in this agreement was a provision requiring the project facilitator to develop all of the accompanying user documentation for the program. In the case of the enhanced routing, the project facilitator remained the primary point of contact for the product development community. The main point is that the level of support received will be a key factor influencing participation in subsequent CTR projects.

Execute Deployment Plans: Once the plans are in place, execution becomes the final step in horizontal deployment. The project facilitator should strive to set an example of fast cycle time by rapidly completing necessary installations (in the case of new IS tools) and making the technical challenges/details transparent to functional users. By minimizing the disruption to current work, the project facilitator builds credibility as someone that generates change while respecting the demands placed on non-staff personnel.

4.2.7 Project Postmortem

The purpose of this project stage is to provide a mechanism for learning across process improvement projects. In a mature CTR Program, one option might include having the multi-functional team present the results of their postmortem to the CTR Steering Committee. Since that Steering Committee acts as a central node for all CTR projects, the learnings from one project would have a better chance of being spread to future projects.

This stage also provides a means of bringing a project to formal closure. This is more important than it sounds since the number of improvement ideas tends to grow during the course of a project. Providing a tangible end point to the "cycle" of a process improvement project allows the team to stop and learn from their experiences. The CTR Program can set an organizational example by making rapid cycle times a cornerstone of such projects. The tasks in a postmortem are described below:

Identify Weaknesses: This is a task that should be completed by the entire project team. A useful tool for this type of qualitative data analysis is the KJ Method[14] which incorporates a team generated affinity diagram. In the case of the material management project, the team never came together for a postmortem. The general attitude was that a postmortem was a waste of time and everyone was to busy for this type of "fluff" work. Note, at the time, there was no CTR Steering Committee to receive the team's findings.

Brainstorm CIP Improvements: The material management project followed a specific continuous improvement process (CIP) methodology. At the end of a project, a team is in a good position to identify improvements to the internal process they followed. Once again, since there was not a formal project postmortem, the team did not complete this task.

Communicate Results: Without formal project closure, it is often difficult to communicate the exact benefits of a CTR Project - even amongst the original team members. The postmortem meeting provides an opportunity for the project facilitator to summarize the benefits of the team's improvements. Details related to the pilot implementations and horizontal deployments can also be communicated to team members - particularly those that have not been active since the process analysis and redesign stage of the project. Sometimes, a lack of information is construed as a lack of progress. If nothing else, the project facilitator should provide this information to the team out of gratitude for the hours that each individual volunteered to the project.

Generate Recognition: The project postmortem provides a convenient forum for recognizing the individual contributions of team members, particularly those that played key roles in pilot implementation and horizontal deployment. The project facilitator should make a special effort to ensure that those contributions are recognized by an individual's peers *and* supervisors. Although there will be pressure to move on to the next CTR project, this last task should not be shortchanged. As mentioned earlier, an effective way to conclude a project is to have the team present the findings of their postmortem to the CTR Steering Committee.

[14]Jiro Kawakita. The Original KJ Method. Kawakita Research Institute. Tokyo, 1991.

4.3 Project Results

Given the organizational culture in this environment, it was important to document the tangible results generated by the material management team. Ongoing funding for the handful of CTR staff facilitators required justification based on objective metrics. In an effort to provide this information, the team outlined the following list of benefits:

Table 4.3.1 List of Project Benefits

Cycle Time:

- Average savings of days/factory-build for shortage analysis (as a result of the Factory Specific Shortage Report).
- Average savings of days/factory-build for moving receipts to stock.

Resources Expended (Labor Cost):

- Savings of 10% hours/factory-build for shortage analysis
- Savings of 10-20% hours/part for incoming inspection
- Savings of 10% hours/part for expediting and chasing part specifications/prints

Payback period:

- Based solely on resources expended:

$$\frac{\text{60\% of total factory build hours (group meetings during process analysis \& redesign)}}{\text{10\% hours saved/factory-build}} = 6 \text{ factory builds}$$

Based on these measurements, the team was successful in shaving an average of a few days off of the cycle time for material management as defined in the team charter. This translates into a cycle time reduction of roughly 30% (versus the team's original goal of 50%). Because the material management process is one of several subprocesses within the overall factory build cycle, it is unlikely that these days of savings will translate directly into days of overall savings for each factory build.

Despite the small reduction in cycle time, this project generated savings in labor costs. Combining the various reductions in resources expended, each new factory build material management cycle will consume fewer man days of labor. This measurable result makes

tangible labor costs, the improvement project will pay for itself within seven factory build iterations. Regardless of the precise payback period, it is clear that this project will pay for itself many times over.

4.4 Lessons Learned

This section will describe the more memorable lessons learned by the facilitator on this material management project. Each lesson will be associated with a specific stage of the project in order to provide a frame of reference:

Looking for problems will create defensiveness (Preliminary Investigation):

During the preliminary investigation stage, one of the facilitator's tasks is to "dig up dirt" and identify problems. When doing this, it is important to remember that certain individuals will be emotionally attached to various parts of a process. Although it is important to avoid putting individuals on the defensive, it is even more important to put their feedback in perspective. Rather than taking interview feedback as factual data, it is important to understand the framework of the interviewee and the potential sensitivities of that person. Otherwise, it will be easy to be led on a wild goose chase in the search for process improvements, especially as an outsider.

Make the sales pitch personal (Team Building):

Unless an individual can envision direct personal benefits from volunteering for a process improvement project, that person is unlikely to participate. Cycle times are nice to talk about, but it is important to relate potential improvements to an individual's specific work problems and their impact on the quality of work life. This is one of the reasons why the team building stage follows the preliminary investigation stage of the project. Preliminary investigations can be used to identify an individual's "hot buttons" prior to making requests for that person's time.

The first step is to generate a common understanding (Process Analysis & Redesign):

At the beginning of the process analysis and redesign stage of this project, the facilitator assumed that most multi-functional team members had a relatively thorough and common understanding of the material management process. That assumption could not have been further from the truth. During the "As Is" process mapping sessions, team members traded moments of disbelief regarding the misconceptions held by individuals from various functions. The "As Is" mapping sessions helped overcome those gaps in understanding and created a common bond among the team. "As Is" process mapping creates a critical foundation for multi-functional process improvement. Without it, the team will never be "on the same page" and consensus will be extremely difficult to obtain.

The necessary information exists (Pilot Implementation):

Both process improvements conceived by the material management team required information to be provided in a new format at a specific time. Once installed, the

factory specific shortage report could be run on-demand by factory material handlers. By simply asking "what if," the team designed new processes that required only minor modifications to the existing information systems. The necessary data had always existed, it just wasn't available in the right format and the right time. This particular lesson has three related corollaries:

MIS must become better marketers:

As a support function, it is easy for an MIS organization to adopt a reactive approach to information system needs. It is not uncommon to hear the following statement from MIS professionals: "If they would just tell us what they want, there would never be any problem." At some point, MIS professionals need to adopt a business perspective and begin to *ask* functional users what they want. Because of their unique knowledge of information system capabilities, MIS can play a valuable role in cycle time reduction by taking an active role in process improvement projects and explaining what is feasible.

Functional groups must become better customers:

In this context, the word "better" implies more demanding from the perspective of improving business processes. Not everyone in a functional role can be a lead user[15] as defined by von Hippel, but the existing information systems need not be taken for granted.

A common language is needed:

Regardless of which role an individual fills, it is not difficult to recognize a lack of effective communication between functional and IS individuals. A first step toward improving the situation is to recognize that two different "languages" are being spoken and to be sympathetic to the differences in perspective. Functional and IS individuals can develop a common language, unique to their own interactions, that is characterized by frequent "backfeed." Backfeed is a term that refers to instances when a listener restates the message he has just heard in order to ensure that the proper meaning was understood. In addition to a common language marked by frequent verification of assumptions, functional and IS individuals need to leave their own work areas and spend time in each other's environment building relationships. This is particularly true of IS individuals whose purpose is to support functional organizations such as manufacturing and development engineering.

There is no substitute for persistence and energy (Horizontal Deployment):

Although the role of neutral party is valuable, it can be argued that the most important role for a CTR project facilitator is that of change agent. The total impact of a CTR project will ultimately be evaluated based on the degree of horizontal deployment. In the role of change agent trying to drive horizontal deployment, a project facilitator will encounter many unexpected barriers - both technical and organizational. Throughout the material management project, the project facilitator found that persistence and constancy of purpose were major factors in persuading even the most change-resistant

[15]Eric von Hippel. The Sources of Innovation. Oxford University Press. Oxford, 1988. Chapter 8.

individuals. From the opposite perspective, the project facilitator also found that even the smallest lapse into negativism or the slightest instance of skepticism can be perceived by those in a position to provide resources. Once skepticism is perceived, one rarely gets a second chance to ask for support or additional resources.

5 Conclusions and Recommendations for Future Research

5.1 Conclusions

Amongst an alphabet soup of improvement programs, cycle time reduction can be the strategic umbrella that integrates organization wide continuous improvement and learning. As a management philosophy, cycle time reduction is as effective in product development labs as it is on the manufacturing floor. It provides a common metric that can be used throughout an organization. An institutionalized cycle time reduction program contributes to a learning organization that intentionally creates, acquires, and transfers shared knowledge that is used as a basis for modifying behavior, generating desired results, and continually expanding the capacity to achieve its core purpose.

At a program level, this research used a specific case to characterize the challenges associated with implementing cycle time reduction in product development. The approach adopted at this facility highlighted the need to understand the organizational culture and the importance of customizing a cycle time reduction program to fit the culture in which it is being implemented. Also, it showed that infrastructural mechanisms are an important means of encouraging the process focus and systems thinking necessary for cycle time reduction. In addition, it provided specific examples of how organizational leaders can support and participate in such a program.

At a project level, this research used a specific case to characterize cycle time reduction by examining the effectiveness of a detailed project execution methodology or tool kit. Direct experience was used to highlight generalizable lessons associated with each stage of that methodology. The preliminary investigation and team building stages were marked by people related challenges. The process analysis and redesign stage showed the importance of building a common understanding as the first step in multi-functional problem solving. Pilot implementation provided an example of the communication barriers between functional and IS individuals. However, this stage also demonstrated the potential of IT based process improvements. The horizontal deployment stage highlighted the need for energetic leadership on the part of a project facilitator.

In the future, as the CTR Program at this research site matures from initiation to institutionalization, cultural and tactical challenges will present a number of opportunities for the business. On the cultural side, there will be opportunities to practice teaming and to expand the time horizon associated with the organization's focus on the present. On the tactical side, there will be opportunities to provide a common understanding of the product development process, to provide common processes, and to provide incentives for process improvement. Now that executive management has recognized that cycle time reduction is a legitimate business need, these opportunities will hopefully result in tangible benefits for the organization.

5.2 Recommendations for Future Research

5.2.1 Decision Making Effectiveness of Various Product Development Models

There are a number of tools that can be used to model the activities in product development. Tools such as Gantt charts, Design Structure Matrices[16], and multi-functional process flow diagrams provide unique frameworks for a variety of research objectives. However, line managers in a product development environment rarely have the time or inclination to use complex models for decision making. If the goal of research is to improve product development performance, it would be useful to study the effectiveness of various models as tools for line managers. It would be useful to conduct a field survey of how line managers use various models and obtain feedback regarding the strengths and weaknesses of those models for specific decision making purposes.

5.2.2 Measurement Systems for Cycle Time Reduction in Product Development

At this research site, one of ongoing challenges is to devise a means for measuring the impact of various multi-functional process improvement projects. Due to the variability across product programs, it is difficult to link standardized process improvements with the total time required to develop a product. The goal of the CTR Program is to generate a significant reduction in the total time required to develop a product. The challenge is in measuring incremental improvements that are not necessarily reflected in macro level metrics. If the time required to complete a factory build iteration is cut in half, will development engineering managers create twice as many iterations? What is the value of being able to iterate twice as fast if the overall development time remains the same? It would be useful to develop a robust measurement system that can be used to evaluate the effectiveness of product development improvements.

5.2.3 Benchmarking Other Product Development Improvement Programs

There is currently a great deal of interest in benchmarking studies, particularly in the area of product development. It would be useful to extend the scope of these studies to include improvement programs (such as Cycle Time Reduction) within product development. How are organizations working to improve their product development performance? If an organization was using TQM to improve its production operations, wouldn't it make sense to benchmark the TQM activities as well as the production operations? There is a need for additional learning histories such as those developed in Chapter three and four of this thesis.

[16]Donald Steward. The Design Structure System: A Method for Managing the Design of Complex Systems. IEEE Transactions on Engineering Management. August 1981.

5.2.4 Revisit the Progress of This CTR Program

After one year of existence, the CTR Program described in this research was on its way to becoming institutionalized. However, there was still progress to be made. It would be interesting to revisit this program in two years and examine the changes in the program as well as the organization. Will there be tangible improvements in the total time required to develop a product? Will teaming be a more significant part of the organizational culture? Will the program be considered a success within the organization? There are still many lessons to be learned from this cycle time reduction program.

Bibliography

Joseph D. Blackburn. Time-Based Competition. Business One Irwin. Homewood, IL. 1991.

Kim B. Clark and Takahiro Fujimoto. Product Development Performance. Harvard Business School Press. Boston, MA. 1991.

Stephen R. Covey. The Seven Habits of Highly Effective People. Fireside. New York, NY. 1990.

Don Clausing. Total Quality Development. ASME Press. New York. 1994.

Margaret B. W. Graham and Dorothy Leonard-Barton. Technology Transfer within the Firm: A Framework for R&D Implementation. Synergy: Conference Proceedings. 1984.

Masaaki Imai. Kaizen: The Key to Japan's Competitive Success. McGraw-Hill Publishing, New York, NY. 1986.

Joh Katzenbach & Douglas Smith. The Wisdom of Teams: Creating the High-Performance Organization. Harvard Business School Press. Boston, MA. 1993.

Jiro Kawakita. The Original KJ Method. Kawakita Research Institute. Tokyo, 1991.

Dorothy Leonard-Barton. Implementation as mutual adaptation of technology and organization. Research Policy 17. 1988.

Dorothy Leonard-Barton. Implementation Characteristics of Organizational Innovations - Limits and Opportunities for Management Strategies. Communication Research. Vol. 15, No. 5. October 1988.

Christopher Meyer. Fast Cycle Time. The Free Press. New York, NY. 1993.

Paul C. Nutt. Tactics of Implementation. Academy of Management Journal. Vol. 29, No. 2. 1986.

George Roth & Art Kleiner. Notes from Learning History Conversation at Bretton Woods Conference June 27th 1994.

Edgar H. Schein. Organizational Culture and Leadership. Jossey-Bass Publishers. San Francisco, CA. 1992.

Peter M. Senge. The Fifth Discipline. Doubleday/Currency. New York, NY. 1990.

Shoji Shiba, Alan Graham, and David Walden. A New American TQM. Productivity Press. Cambridge, MA. 1993. pp. 119-121.

Preston G. Smith and Donald G. Reinertsen. Developing Products in Half the Time. Van Nostrand Reinhold. New York. 1991.

George Stalk and Thomas Hout. Competing Against Time. The Free Press. New York, NY. 1990.

Donald Steward. The Design Structure System: A Method for Managing the Design of Complex Systems. IEEE Transactions on Engineering Management. August 1981.

Philip R. Thomas. Competitiveness Through Total Cycle Time. McGraw Hill. New York, NY. 1990.

Eric von Hippel. The Sources of Innovation. Oxford University Press. Oxford, 1988. Chapter 8.

C.A. Voss. Implementation: A key issue in manufacturing technology: The need for a field of study. Research Policy 17. 1988.

Stephen C. Wheelwright and Kim B. Clark. Revolutionizing Product Development: Quantum Leaps in Speed, Efficiency, and Quality. The Free Press. New York. 1992.